Presence and Effects of Loss Aversion in an Adventure Video Game

A thesis submitted to the
College of Graduate and Postdoctoral Studies
in partial fulfillment of the requirements
for the degree of Master of Science
in the Department of Computer Science
University of Saskatchewan
Saskatoon

By
Natanael Bandeira Romão Tomé

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Abstract

Loss aversion is a cognitive bias in which the negative feelings associated with prospective losses have a greater magnitude than the positive feelings of winning equivalent gains. Although well studied in behavioral economics, there is little understanding of whether and how it arises in game contexts. In games, the "magic circle" may free players from their held attitudes, especially because in-game losses and gains are virtual. On the other hand, experienced immersion and a desire to achieve may make in-game decisions similar to out-of-game contexts. Knowing whether cognitive biases like loss aversion affect players is important for game designers when they create decision points and choices for players. We created a highly representative *Zelda*-style game with several decision points, which ranged from 10 to 18 points, and carried out three experiments with a total of 300 participants, consisting of wagering gold at different win:loss ratios. Our results show that despite the temporary and digital nature of the game world, and the virtual and limited nature of the game currency, players still exhibited a strong bias towards avoiding losses in all experiments. Our findings imply that designers should understand and account for loss aversion when setting up risk and reward structures in their games.

Acknowledgments

First, I would like to thank my co-supervisor Carl Gutwin, which gave me the chance to come to Canada and the support to become a better researcher.

Thank you to my co-supervisor Madison Klarkowski, and Cody Phillips, Regan Mandryk, and Andy Cockburn, co-authors of the paper published from this thesis. It was a pleasure to work with you, I was able to learn a lot from your experience and feedback.

I would also like to thank my colleagues at the HCI lab, which are one of the main reasons the work environment from the lab is so awesome. The help I received with the bazillion prototypes that were created for this project was immense.

I am very grateful to my parents, Sandra and Fred, that always supported me with all decisions I made. I could not ask for better parents.

I would like give a big thank you to my wife, Bruna Rocha, that not only was my biggest supporter from the get go, but was also able to endure listening me rambling about this project for over a year, which was impressing.

Lastly, thank you to the cutest dog in the world, Eevee, that followed me through the many all-nighters I had during my master's program, and always reminded me to drink water during writing and prototyping sessions by scratching my legs every 30 minutes.

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List of Abbreviations

GCA	General Cognitive Ability
NPC	Non-Playable Character
PGSI	Problem Gambling Severity Index
MTurk	Amazon's Mechanical Turk
HCI	Human-Computer Interaction

Glossary

Apex Legends A free-to-play shooter game.

Battle Royale Game genre that involves dozens of players fighting and surviving in an arena, until only one remains.

Counter-Strike: Global Offensive A team-based action shooter.

Dungeon Crawler Game genre where players navigate through mazes, battling monsters and collecting resources to increase their power.

First-person Shooter Sub-genre of shooter games, where the player views the game through the eyes of the character they are playing.

Fortnite A free-to-play Battle Royale game.

Gamification Use of game elements in contexts outside of games.

Grand Theft Auto Series of action-adventure games, that contains a expansive world and is known to grant a large amount of freedom for the players.

Kill-death Ratio Term used to define the number of kills a player can get before each time they die and resumes the play again. In other words, is number of kills divided by deaths.

League of Legends A free-to-play team-based multiplayer game.

Loot Goods that a player can get from defeated enemies.

MMORPG Role-playing games defined by a very large number of players participating at the same time.

Non-Playable Character Characters in a game that are not controlled by a human.

Overwatch A team-based futuristic shooter.

Powerup Bonus that a player can collect to improve their status or give an extra advantage.

Roleplaying Game Game genre that heavily relies on a big story and setting.

Skins Items that players can acquire in a game that changes the visual of the character they control.

The Witcher Medieval action roleplaying game based on the book series of the same name.

Tomb Raider Action-adventure franchise of games.

V-bucks Game currency from the game Fortnite, that can be acquired with real-world currency.

Zelda-like Term used to refer to top-down action-adventure games inspired by the The Legend of Zelda series of games.

1 Introduction

1.1 Motivation and Problem

Loss aversion, a cognitive bias explained by Prospect Theory [78], is a phenomenon of human behavior and decision making that refers to people's tendency to "prefer avoiding losses to acquiring equivalent gains – it is better to not lose $5 than to find $5" [139]. Behavioral economists such as Tversky and Kahneman have shown that loss aversion occurs in many scenarios [130, 131]; however, there is little knowledge about whether this phenomenon occurs in videogames.

The role of loss aversion in games is currently not well understood. There is an argument to be made for its reduction: games provide an alternate environment in which people are able to act differently than they do in the physical world (e.g. the "magic circle", and the blurred boundaries between the game world and the physical world [34, 102, 124]). Since stakes are lower in games, players can take actions they would be unwilling to take in their ordinary lives—for example, choosing to break traffic rules and evade police capture in the Grand Theft Auto series.

However, an argument can likewise be made for the ongoing presence of loss aversion in games. Players are still keenly aware of risks and rewards in games, and may simply be re-calibrating to the realities and expectations of the game world. For example, a player who wants to complete a mission in *Grand Theft Auto* may be risk averse in scenarios wherein attracting police attention could result in the loss of assets, progress, or opportunities.

Games also provide digital currencies that, although purchased by fiscal currencies, employ methods of obfuscating that translation (e.g., V-bucks in *Fortnite*). Game currency, and the assets purchased with it, are digital (leaving aside games in which virtual items can be sold for real world money). If the gold pieces gained in a dungeon crawler are simply "play money", players may not have any strong aversion to loss. This is similar to settings in which people who would not normally gamble are given money to spend at a casino—the fact that losing their initial stake does not involve the player's own money, as well as the primarily hedonic rather than utilitarian aim of gambling, may reduce loss aversion [36, 111, 125]. However, players may again be re-calibrating to a game world in which objects and money have varying degrees of utility for achieving ends in the game. If gold pieces in the dungeon crawler have utility—for example, if they allow the player to purchase a better weapon—then the gold may no longer be perceived as value-less "play money". Games further allow people to interact with digital assets on a regular basis. Inventory management systems, game lobbies, and new daily or weekly items all encourage players to frequently interact with their in-game assets and currencies. Subjective value (according to economists) describes what people are willing to pay for an object [113]. Popular and commercially-successful games like *Fortnite* and *League of Legends* are free-to-play and generate revenue primarily from the sale of "skins", which are primarily cosmetic and have little in-game utility. The fact that players spend significant money on these game assets suggests that they have high subjective value. Additionally, that players spend time and effort building up their digital assets, suggests that these digital characters, weapons, and currencies have very real value to players as they interact with them over time [88].

These arguments show that it is unclear whether loss aversion will manifest in game environments. Gaining this knowledge is important for game designers, because the ways in which games set up decision points and choices for players can have a large effect on player enjoyment and retention. For example, designers may build decisions that involve risks and rewards into a game that is designed to be played aggressively, but if players are loss averse, they may miss out on many of the game's possibilities, creating a game experience very different than what the game designer envisioned. Furthermore, games that are combat-oriented—such as multiplayer first-person shooters and battle royales—may unwittingly disincentivize combat if the rewards for defeating enemy players (e.g., loot, currency, points) do not outweigh punishment for failure (loss of loot, loss of currency, match loss). Clarifying the role of loss aversion in games will allow developers to make more informed decisions about gameplay design and reward structures, promote the creation of interesting player choices and dilemmas, and further advance research related to player's experience, human cognition, and cognitive biases.

1.2 Solution

To provide an initial understanding of whether loss aversion occurs in games, we built a highly representative custom adventure-style game with several decision points that allowed us to measure players' loss aversion. The studies involved three experiments, with 10 to 18 game rounds each: in each round, the player fought their way through waves of enemies, gathering gold by defeating monsters and opening treasure chests, and then entered a building where they had the opportunity to wager some of their gold based on the outcome of a coin flip. Gold could be used later in the game to buy one of two powerful swords. Wagers had different win:loss ratios – some favorable for the player (e.g., win 1000 : lose 500) and some unfavorable (e.g., win 500 : lose 1000) – and we recorded the number of players who took the wager at each win:loss ratio. If players are loss averse, they will accept favorable wagers at a lower rate than they reject unfavorable ones, and wagers will only be accepted by the majority when ratios are strongly weighted in the players' favor.

1.3 Evaluation and Contribution

We recorded players' willingness to take each wager, demographic variables such as gender, age, gambling history, and player type, and also measures of play experience toward our currency in the game, with 300 participants completing the experiments using Amazon Mechanical Turk [30]. Our studies provide several new findings about prospect theory and, more specifically, loss aversion in games:

- Loss aversion clearly occurred in all experiments: paired Wilcoxon rank sum tests (two-tailed) on pairs of equivalent wagers (e.g., 0.25 and 4.0) showed overall that players were reluctant to take wagers until the win:loss ratio became strongly favorable, showing an overall bias towards avoiding losses;
- In all experiments, loss aversion was significantly more pronounced when there was a larger amount of money at stake;
- Gender differences does not seem to be a reliable way to assess loss averse behavior, with mixed results found between our experiments. Further, different player groups – age, player type, and gambling risk – did not substantially change loss aversiveness in all experiments;
- In all experiments, players' subjective satisfaction with their progress was reduced substantially more by losing a wager than it was increased by winning a wager, an indication that even in games, "losses loom larger than gains." [78].

These results show that players in an adventure-style game behave in a similar fashion to people in previous studies of loss aversion in other contexts, even though the money in our game was not real, and its utility was purely for an in-game purchase at the end of the game. This means that designers should take loss aversion into consideration when designing decision points in games, as players may otherwise avoid interacting with game features that the developer wishes to make appealing. Further, game designers may be able to leverage loss aversion to create engaging choice-based dilemmas for players, and may be able to manipulate risk and reward in order to influence the paths that players take through a game.

Our work makes three main contributions. We are the first to test loss aversion in a commercial-style video game, and the first to show empirically that loss aversion exists in that context. Second, we have extended previous work on prospect theory by showing that loss aversion does exist in game domains, and provided an understanding of utility in games that can help designers understand what in-game objects are truly valuable to players. Third, we provide a methodological framework for studying loss aversion in games that can be applied to other cognitive biases. Overall, the novelty in this research is not in changing what we know about prospect theory and loss aversion other than clearly showing another setting in which loss aversion exists, helping game designers that have not previously considered the influence of prospect theory and loss aversion, and have not been guided by the literature when building games that are more engaging for a wider variety of players.

1.4 Thesis Outline

Chapter 2 provides a synthesis of related work concerning cognitive biases and loss aversion, as well as games research regarding the magic circle, the value of rewards and in-game items, and the ties that physical-world economies have in game economies. Chapter 3 presents a thorough explanation of the game developed for the experiments, as well as detailed information of the differences between the three experiments, how the wagers were designed, what measures where used to gauge loss aversion, and the procedures used to screen participants and run the experiments. Chapter 4, 5, and 6 shows the results of each experiment individually. Chapter 7 discusses the general findings observed from all experiments, as well as applications of these findings for game design, limitations, and opportunities for further research. Chapter 8 concludes the thesis with a summary of the work and main findings.

1.5 My Contributions

This thesis is based on the paper titled "Risking Treasure: Testing Loss Aversion in an Adventure Game", a team effort successfully published at CHI PLAY 2020, written by me, Madison Klarkowski, Carl Gutwin, Cody Phillips, Regan Mandryk, and Andy Cockburn. I was involved in all parts of the research process, including:

- Idea generation;
- Study design;
- Design, development, and implementation of the game used in the studies;
- Recruitment of participants;
- Creation, deployment, and moderation of usability tests;
- Creation and deployment of unmoderated online studies using MTurk;
- Data collection and analysis;
- Paper writing.

2 Related Work

2.1 Cognitive Biases and Loss Aversion

2.1.1 The Origin of Cognitive Biases

Cognitive biases were first introduced by Tversky and Kahneman [130] and are usually described as heuristic principles that allow individuals to save time and reduce task complexity when dealing with numerous daily decisions. Cognitive biases can lead to systematic errors of judgment [130, 61] and can be detrimental to our lives, being related to mental health disorders [121, 82, 15], eating disorders [140, 141], decision errors in the legal system [31, 108, 137], and so on. However, some biases are believed to have originated from evolutionary adaptations [62, 60] that may improve decision making efficacy [71]. Haselton et al. [62] categorize cognitive biases in three areas: shortcuts (heuristics) that lead to fast decision making, but can also be inadequate for the situation; decisions that are not suitable for modern contexts, which they refer to as "artifacts"; and decisions that can lead to increased error rates but reduce resource consumption (error management biases).

2.1.2 Prospective Theory

Taking cognitive biases into consideration, Kahneman and Tversky investigated economics through the optics of psychology – later known as behavioral economics [33]. In doing so, they developed the "prospect theory" descriptive model for decision making [78]. This model suggests that people are more willing to accept greater risks to avoid negative outcomes, while they are simultaneously more risk averse when the uncertain outcomes are more positive. This is because the experience of loss is valued as approximately twice as impactful as the experience of wins – as demonstrated by the prospect theory value chart, shown in Figure 2.1. Kahneman and Tversky further suggest that decisions are made relative to a neutral reference point, instead of taking into consideration only the final outcome. These concepts contribute to a cognitive bias known as "loss aversion".

2.1.3 Loss Aversion

Loss aversion refers to the tendency to overweight the drawbacks of losses in comparison to the benefits of comparable gains. In other words, losing something is more impactful than winning something of equivalent value [75]. This phenomenon can be observed in a variety of contexts, such as the stock market [11, 17, 18, 54], politics [4, 70, 85], and marketing [21, 81, 101], and can also be observed in risky (e.g., small scale gamble) and riskless (e.g., someone is given a mug and asked if they wanted to trade it for a pen) situations [44, 127, 131].

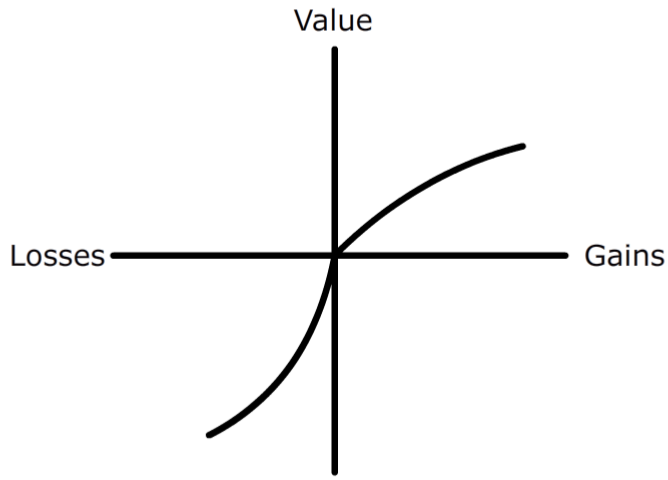

Figure 2.1: Representation of a hypothetical prospect theory value chart.

Commonly, loss aversion studies examine a willingness to wager in a random lottery where real money is given to or taken from participants depending on their decisions [29, 44, 143]. For instance, Gächter et al. [44] measured loss aversion in risky choices by using lottery choice tasks. These tasks consisted of participants choosing if they wanted — or not — to play in each of the six lotteries presented, all of them with fixed gains of €6 and losses that varied between €2 and €7. The authors not only were able to observe loss aversion behavior in these small-stake lotteries, but also used their previous analyses of loss aversion in a riskless choice task to make a positive correlation between loss aversion in risky and riskless situations.

2.1.4 When Loss is Reduced or Reversed

There are some situations in decision making in which loss aversion is either not demonstrated or is undermined. For example, loss aversion has not been reported in financial transactions wherein buyer and seller expectations are fairly met [97]. Loss aversion is further reduced when decisions are made for others [6, 107], and when monetary loss is relatively small [58]. In gambling contexts, techniques are employed to reduce the pain of loss and motivate continued gambling - such as making large losses seem small [120], and framing the experience as hedonic instead of utilitarian [50, 95].

2.2 Cognitive Biases in Games

2.2.1 Video Games and Cognition

Several areas of research indicate that video game play can affect player cognition [112]. For example, video games have been found to improve reaction time [10, 128], attention [9, 10, 128, 138], visual recognition memory [10, 128], selective visual attention [16], cognitive control [7], and spatial orientation [14, 42, 138], and have also been employed as a useful tool for cognition evaluation and attenuation [8, 13]. However, the validity of video game training — as well as other cognition training activities — as a way to increase general cognitive ability (GCA) is still a much debatable subject, with several researchers claiming that the effects of video games on cognition improvement are not significant or non-existent, and that positive outcomes from previous research were due to methodological issues [26, 133, 114, 115].

2.2.2 Video Games and Bias Mitigation

The efficacy of video games in the reduction or modification of cognitive biases has received notable academic attention due to their interactive nature and potential to provide fast feedback. For example, Dunbar et al. [39] developed a serious strategy game intended to inform players about the existence and effects of specific cognitive biases. The authors found that exposure to a single-player version of their game reduced the effects of both confirmation bias and fundamental attribution error in their participants. Other uses of games in bias mitigation research include the comparison of a game and a training video in regards to mitigating fundamental attribution error, confirmation bias, and bias blind spot [118], the development of a serious adventure game with storytelling elements to reduce cognitive biases in teachers [12], and the reduction of alcohol and drugs attention bias by using gamified applications and serious games for health [22, 23, 24].

2.2.3 Effects of Cognitive Biases in Video Game Players

Besides bias mitigation, there are few studies exploring the effects of certain cognitive biases in video game players. For example, Gutwin et al. [53] examined a psychological bias called the "peak-end rule" in casual games. This bias is defined by the importance people place on both the peak and final moments of an experience, which can lead to different perceptions of a whole experience. The authors were able to change participant's recollection of challenge by creating multiple variants of the same game – finding that variants with easier end challenges were perceived to be overall less challenging than variants with more difficult end challenges. Other studies include the temporary development of hostile attribution bias by playing violent games [25, 79], and the relationship between attentional bias, addiction disorders, and video games [132].

2.2.4 Loss Aversion and Game Design

Loss aversion in games has received little research attention. Hamari [56] points out that some social games may use cognitive biases related to loss aversion. For example, a game may stimulate user retention through the endowment effect, in which individuals place greater value on goods that they already own, such that they may value something that they own more than something they don't own, even if the unowned item's objective value is marginally higher. A depletion mechanic – in which an in-game resource, such as a crop, depletes over time without user interaction – may utilize this effect to encourage user retention. This "loss of opportunity" mechanic can also work in the form of returning bonuses for players, invoking loss aversion due to the feeling that said bonus is already owned by the player [32, 86].

In mobile application design, Stockinger et al. [122] developed a gamified personal finance app that utilizes several cognitive biases to help users make more informed financial decisions. Loss aversion is invoked through the removal of previously awarded badges in instances of inadequate player performance. This strategy of threatening to remove something earned if a desired behavior is not displayed has been observed to be more effective for certain player types. Orji et al. [98] find that loss aversion as an engagement mechanism is more effective for players categorized as 'achievers', 'masterminders', and 'socializers' within the BrainHex model of gamer types (see Section 3.5.1 for more details).

Despite the ample implementation of engagement mechanics in games, very few empirical studies exist formally in the realm of loss aversion and game design - which instead mainly focus on applying concepts of cognitive biases in gamified applications [35, 69, 123]. Our studies have the distinction of applying loss aversion concepts in a custom-made digital entertainment game, as opposed to a serious game or a gamified application.

2.3 Games as Different from the Physical World

2.3.1 The Magic Circle

The magic circle was first introduced by Huizinga [68], who described it as a space of play, isolated and with a clear border from the outside, created by players, and with its own set of rules. This definition was later expanded by Salen and Zimmerman [116] to describe the boundaries of games (digital or otherwise), wherein players give their consent to voluntarily enter a space governed by well-defined rules and set apart from the outside world. This definition of the magic circle in games has been adopted extensively in games research (e.g., [37, 102]), and especially within the topic of pervasive games [59, 92, 96, 117] – but is also criticized, with many disagreeing with the concept of a separation between 'real' and 'play' worlds [34, 124, 37, 102]. Some additional criticisms of the video game magic circle include: the generalization of the magic circle to any type of game [87, 37, 124]; the idea of players having both a 'real' identity and a 'ludic' identity [142, 37]; the belief that external contexts do not influence in-game behavior and experience [87, 124]; and the lack of relevance and utility of this concept in game studies [142, 37].

Other theories have been proposed to explain the power games have to engage and immerse people in their virtual worlds, and how a game world interacts with the physical world. For instance, Juul [72] proposes that the magic circle exists and, contrary to popular belief, the separation between worlds is not meant to be perfect. Instead, he argues that the magic circle is "an imperfect separation that players negotiate and uphold" [72]. Pargman and Jakobsson [102] adopt a similar stance against the strong-boundary hypothesis, instead suggesting that players switch between different states of mind in a gaming situation called 'frames'. For example, someone playing an MMORPG can go from a more "ludic" frame, incorporating characteristics from their game avatar and being immersed in the virtual environment around them, to a "life" frame when stopping the game to go to the bathroom or read emails (or even within the game when talking about a "real" world event). Both theories provide explanations on how people interact with games and the world outside, while proposing that the boundaries between these worlds are not as strong as earlier definitions of the magic circle suggested.

Regardless of the strength of the boundaries between the physical and game worlds, it is usually agreed that people commonly perform actions in games that they would not - or cannot – perform in real life. From stealing cars in *Grand Theft Auto* to exploring dungeons in *Tomb Raider*, actions performed in games generally have few consequences in the physical world. Consequently, failure in games is accepted by players as a way to learn and progress further [47, 49], increasing overall enjoyment during the game experience [74, 73]. However, it is not known whether reduced stakes and more ready acceptance of failure modifies the influence of loss aversion in video games – as compared with physical world settings.

2.3.2 Game Rewards and Value of In-Game Items

Reward systems are an important characteristic of games, serving as motivational components to encourage players' progress and enjoyment [104, 109, 135]. Various taxonomies have been created to better organize and understand different types of rewards [55, 105, 106, 109, 135], presenting categories that refer to the acquisition of virtual items, such as "item granting system rewards" [135], "rewards of facility" [55, 105, 106], and "enabling rewards" [109]. Each of these suggest that rewards are a ubiquitous feature of video games.

As with reward systems, there are many attempts to categorize and create a definition of in-game items [52, 65, 84, 103]. We highlight Park and Lee's proposal [103], which defines game items based on four dimensions of value: character competency value, which represent the performance advantages that an item can give to the player's avatar, such as more power, speed, or defense; enjoyment value, which relates to how items facilitate the act of engaging and having fun in a virtual world; visual authority, which covers the cosmetic aspects of items, which entail changes to the player's avatar and increase of their social status in the context of a game; and monetary value, which, as the name suggests, relates to how much monetary value players give to items before purchasing them. The authors also suggest that preference for items that have more utilitarian value vs cosmetic value change based on the game genre. For example, MMORPG players tend to value visual authority more than first-person shooters and casual game players.

2.3.3 Game Economies vs Physical-World Economies

Money acquisition is an important source of motivation for people; but although video games players have many motivations to engage in virtual worlds, collecting in-game currency is rarely specifically described as a goal. Motivations for gameplay range from passing time, relaxation, and avoiding boredom, to competition, challenge, and social interaction [119, 144, 41]. Video game currency is, in theory, just another element in game design to engage players and facilitate the act of having fun in virtual worlds. While some digital games contain ways to trade in-game items or in-game currency for real monetary value (e.g., the *Counter-Strike: Global Offensive* marketplace [46], see Figure 2.2) the value of in-game money is generally limited to the game environment.

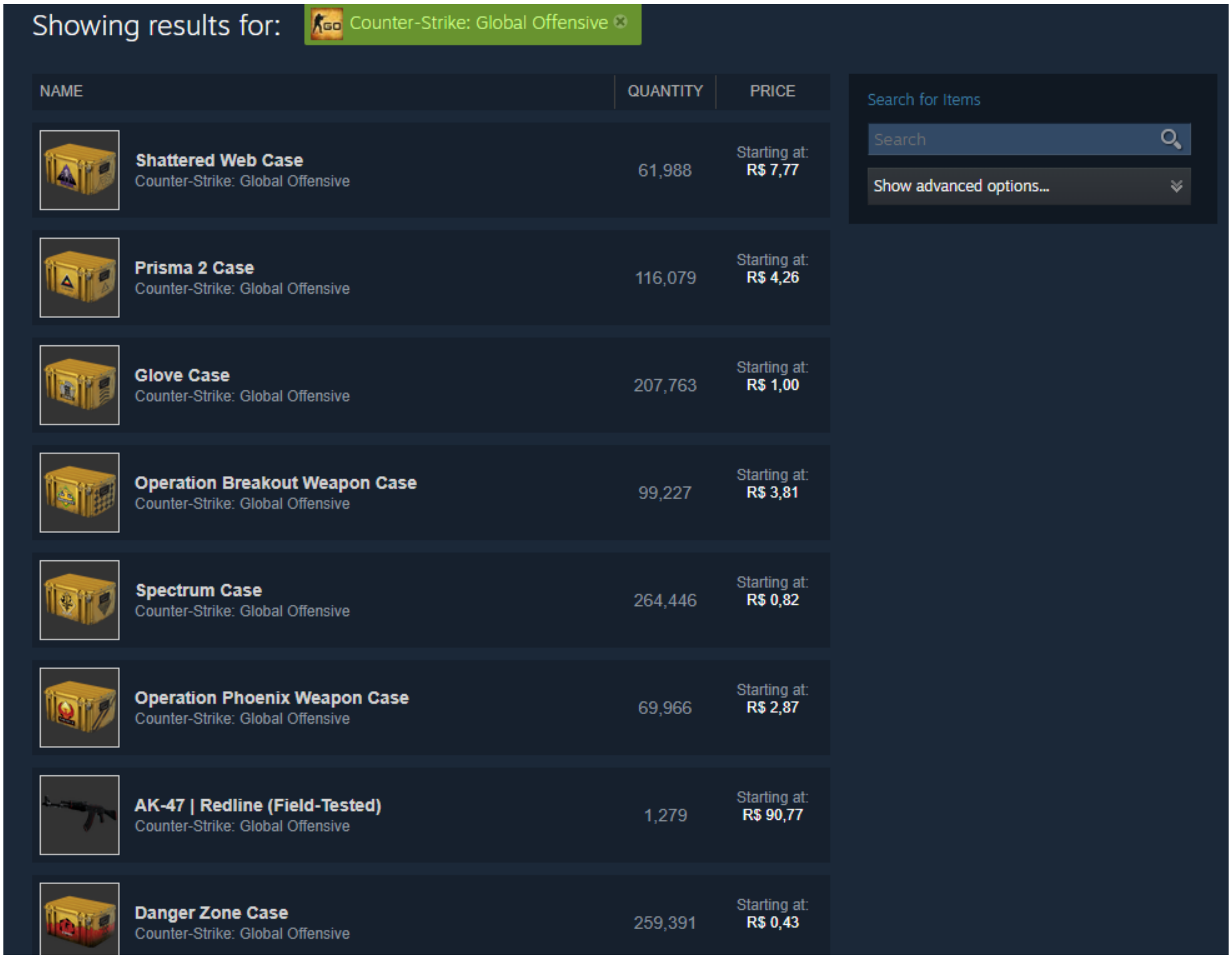

Figure 2.2: Screenshot of the *Counter-Strike: Global Offensive* marketplace.

However, even in games where the act of selling virtual goods for “real” monetary gain is actively discouraged and punishable by the developers, it is not uncommon for players to engage in such transactions. Research on these types of game economies and their ties to the physical-world economy (e.g., [57, 83, 91, 126, 136]) mainly focuses on MMORPG economies and the utility of in-game money and virtual goods compared to their physical counterparts. For example, Wang and Mainwaring [136] conducted an exploratory ethnographic study in China to understand the impact of virtual currencies in online games, and highlighted three major issues: realness, which correlates to how virtual currencies with ties to the physical world (which the authors define as “gateway currencies”) are designed to feel like “fake money”, to facilitate the act of spending money without the spender giving too much thought to it; trust, which relates to the difficulties players have carrying out cash transactions and sharing accounts with other players, both being practices very common in online games but not supported by developers, which lead to alternatives where players are prone to being scammed by other players; and fairness, which refers to the power that real money has in buying in-game advantages, which can break the balance of a virtual world.

Our studies differ from previous work by analyzing the effect of loss aversion in a short single-player game experience, with a closed in-game economy, using gambling mechanics utilizing a currency that can only be acquired and exchanged within the game world. This allows for analysis of how much utility players assign to the acquired game currency that is free of ties with the physical-world economy, how open they are to risking currency acquired in the game, and how losing or gaining this currency will affect their satisfaction while playing the game.

3 Study Design and Methodology

Our studies consisted of three experiments, each one conducted with different participants and using the same custom game, with some differences in each one of them. We will highlight these differences in the sections they are presented.

3.1 Goals of the Study

The goals of our studies were:

- Find out whether loss aversion occurs when players are given the chance to wager in an adventure-style videogame;
- Check if the degree of loss aversion was affected by various variables, such as the amount of the wager, social-demographic factors, and participant's subjective satisfaction with their progress;
- Collect participants' feedback regarding their attachment to the in-game currency.

3.2 Rationale for the Three Experiments

We carried out three studies that explored different configurations of our main study factors. The first experiment examined wager behavior in games, but did not consider the concept of "equivalent wagers". Further, Experiment 1 utilized losses fixed at half of player wealth. The second experiment added the idea of equivalent wagers – and removed fixed losses. Finally, our third experiment adapted the design of the second by maintaining the same number of wagers, but re-introduced fixed losses and more clearly delineated between low and high values.

3.3 Custom Game

We developed a custom 2D *Zelda*-like adventure WebGL computer game in Unity 2019.1 called *Small Adventure*. The game was designed to resemble commercially-released games, as to maintain a high level of ecological validity (i.e., capable to be generalized in a real-life setting) to our experiments. Players controlled their avatars with a keyboard (for movement and battle) and mouse (for selecting answers). The game consisted of players killing monsters, opening treasure chests, progressing through different levels, and having the opportunity to wager some of their gold in specified locations.

3.3.1 Shops

Shops were locations where players could buy a sword or wager their gold. These locations were divided in three categories:

- Initial Shop, the first location and shop of the game. Players had to buy the starter sword to leave this shop, which they would use for most of the game;
- Transition Shop, consisted of shops players would go between levels, except for the "Final Shop". Players were able to engage in wagers, interact with the shopkeeper, and check if they had accumulated enough gold to unlock the more powerful swords;
- Final Shop, the last shop of the game. Players could engage in their last wager in this shop, as well as buy one of the more powerful swords.

3.3.2 Decision Points

We define decision points as the moments where players had the opportunity to wager gold acquired beforehand, with a 50% chance of winning or losing. They were presented in each shop players went after finishing a battle, and could not be skipped. Experiment 1 consisted of 10 decision points, while Experiments 2 and 3 consisted of 18, and players were asked how satisfied they were with their progress following a decision point (See Figure 3.1). Although several prior studies of loss aversion obtain only one decision point from each participant, we opted to introduce additional decision points to emphasize ecological validity: a game with a single decision point would be unrealistic in terms of real-world game design, as games typically contain multiple decision points. Furthermore, obtaining a single decision from each participant would have been inefficient in light of the considerable time spent training participants on the game.

Figure 3.1: Question regarding player's subjective satisfaction, presented after each level.

3.3.3 Trickster's Treasure Chest

Players had to interact with a purple treasure chest called "Trickster's Treasure Chest" (See Figure 3.2) to start a wager and open the exit to the shop, even if they did not had an intent of wagering (i.e., they had to check the wager conditions before rejecting them). Interacting with it would open a prompt (See Figure 3.3) that showed:

- How much the player could win or lose if they accepted the wager;
- The probability of winning or losing (50% for each);
- and two buttons labeled "Open it anyway" (i.e., accept wager) and "Leave it Alone" (i.e., do not accept wager).

After interacting with a trickster's treasure chest, players would not be able to interact with one again in the same shop, even if they decided to reject the wager previously.

Figure 3.2: Screenshot of one of the shops of the game, with a trickster's treasure chest in the middle.

3.3.4 Game Currency

Gold was the currency created for the game, which could be collected by:

- Defeating monsters;
- Opening treasure chests;
- Wagering gold in shops.

Gold acquired by killing monsters had different colors, with each color indicating a different value (see Figure 3.6), ranging from one (yellow coin) to 10,000 (pink coin). Players would get progressively more gold defeating enemies as they progress in the game and defeat harder foes, as well as by wagering.

We set up the game so that the player's gold would have a clear utility – that is, the gold was useful because it would eventually allow players to purchase a more powerful sword. The game was also designed to give players a sense of ownership over their gold, because much of the gold was "earned" through fighting and defeating monsters. However, the gold had only a future utility because players could not use gold in the levels to buy other items such as health packs or powerups.

Figure 3.3: Depictions of gold in the game.

3.3.5 Swords

We introduced swords in the game as a reason for players to collect and get attached to our game currency. These swords were displayed in all shops, but – with the exception of the starter sword – their cost was hidden until players had accumulated enough gold to unlock them. There were three swords in the game:

- Starter sword, with one attack point, obtainable at the start of the game for just one gold;
- Mid-tier sword, with five attack points, obtainable at the end of the game. The cost of this sword was 40,000 gold in Experiment 1, and 900,000 gold in Experiment 2 and 3;
- High-tier sword, with ten attack points, also obtainable at the end of the game. The cost of this sword was 60,000 gold in Experiment 1, and 1,300,000 gold in Experiment 2 and 3.

We increased the cost of swords in Experiment 2, because we wanted players to receive an increasing amount of gold when finishing each level, to match the game's increasing difficulty. Further, we wished to more clearly separate low and high values for our wager analysis.

Figure 3.4: Screenshot of the game depicting an interaction with a trickster's treasure chest, where players have the option to open the treasure chest (i.e., wager) or leave it alone (i.e., not wager).

3.3.6 Shopkeeper

Each transition shop had a shopkeeper, which was a non-playable character (NPC) with a dialog that would set the swords as a clear goal for the player (See Figure 3.4). If they could accumulate enough gold, they would be able to buy the mid-tier sword (+5 attack) or the high tier sword (+10 attack). A progress bar shown above the dialogue indicated the player's relative progress toward the goal of being able to buy the swords. This bar was manipulated to show a slightly higher gold value than what the player had at the moment, to avoid players feeling that the swords were unattainable, since if we used the absolute values for the first levels, the progress bar would not move at all.

3.3.7 Enemies

There were three types of enemies in the game (See Figure 3.5):

- Melee tree logs, that would chase and attack players by touching them;
- Ranged tree logs, that would shoot pellets across the level, with different speeds depending on how far (faster speed) or close (slower speed) players were to them;
- Cyclops, melee monsters that attacked with a club and dealt more damage than tree log monsters, but were slower.

Each monster had other difficulty types identified by their color, each one increasingly faster and more resistant than the previous one. These stronger monster variants would appear more frequently in late stages and require more hits to defeat, ranging from two to ten hits.

Players could attack enemies by using the sword they bought or arrows (after acquiring a bow), and defeated foes would drop loot in the form of gold coins, as well as hearts (life points) and arrows (ammunition for the bow weapon).

Figure 3.5: Example of interactions with the shopkeeper. Top: dialog after decision point 1, from Experiment 1. Bottom: dialog after decision point 8, from Experiment 1.

3.3.8 Levels

The game consisted of 10 levels in Experiment 1 and 18 levels in Experiment 2 and 3, each containing a shop and a decision point. Each level was divided in two segments:

- An exploration segment, where players could familiarize themselves with the level, acquire items (e.g., players picked up a bow for ranged attacks in the second level), and be introduced to new stage mechanics (e.g., the teleport mechanic, as seen in Figure 3.7);

Figure 3.6: Left: melee tree log. Middle: ranged tree log. Right: cyclops.

- A battle segment (see Figure 3.8), where players had to fight and kill five waves of monsters in Experiment 1, and two waves of monsters in Experiment 2 and 3.

Players had to kill all monsters, collect all gold dropped from them, and open a treasure chest that appeared after defeating all enemies to be able to open the door to the next shop. If the player was defeated in battle, the game would restart the level, with the player maintaining the same amount of money they had when they first entered the level.

Figure 3.7: Example of exploration segment, where players learned how to use the teleport mechanic.

In all experiments, players would go to an extra level of the game after engaging in the last decision point, which did not had a following decision point and was created to give players an opportunity to use one of the stronger swords (if they decided to buy one previously) before the game ended.

3.3.9 Walkthrough

After checking the controls and clicking the "Start" button (see Figure 3.9), participants started the game inside the Initial Shop and with one gold, and were forced to buy a sword to proceed. We enforced the necessity to buy a sword before proceeding to teach them that gold is the game currency, and that they can buy weapons with it. Only one sword – with one attack point – from the three initial ones could be bought

Figure 3.8: Example of battle segment, where players fought monsters.

(See Figure 3.10), with the other two more powerful swords unavailable. A messaged would be displayed if players tried to buy one of the other swords, stating that they could not afford them, but the actual price of these swords would not be shown (See Figure 3.11).

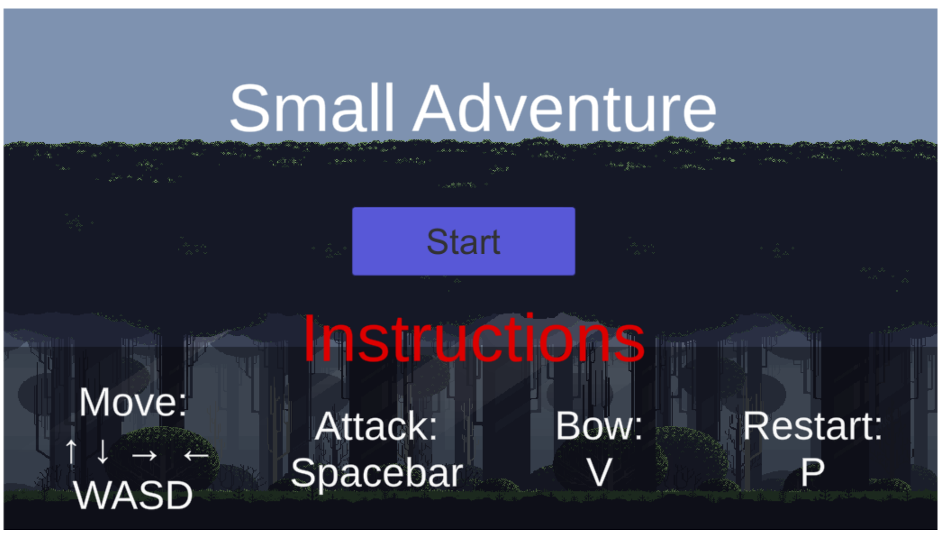

Figure 3.9: First screen of the game.

After leaving the initial shop, players would be sent to the first level of the game, where they had to go through a exploration segment and a battle segment. To complete a level, players had to enter a shop and choose if they wanted to wager their money on a trickster's treasure chest or not. After the outcome of their decision, players could leave the shop and go to the next level, where they had to respond a question asking how satisfied they were with their progress. This pattern of beating monsters, wagering, and responding questions would repeat across all levels — ten in Experiment 1 and 18 in Experiment 2 and 3 — until players arrived at the Final Shop.

In the Final Shop, players would be informed before engaging on a wager that this was the last shop in the game, and they already had enough money accumulated to buy the mid-tier sword, but would have to wager to have enough money to buy the high-tier sword (see Figure 3.12). Knowing that this was their last opportunity to bet, participants had four different options:

- Do not wager their money and buy the mid-tier sword with the money they had;
- Wager their money for a chance of buying the high-tier sword;
- Wager their money and buy the mid-tier instead of the high-tier sword;
- Do not buy a sword, regardless if they wagered or not, and write down the reason (see Figure 3.13).

After leaving the last shop, participants were transferred to an extra level of the game, where they had to either defeat stronger enemies if they bought a sword – now weaker due to the better stats of the sword purchased – or standard enemies if they did not buy a sword previously. After leaving the extra level, players rated their level of satisfaction with their progress one last time before the game finished.

Game Loop

The game loop of all experiments can be summarized in Figure 3.14.

3.4 Design of the Wagers

The design of the wagers was inspired by previous work by Tversky and Kahneman on loss aversion, decision making, and prospect theory [75, 76, 77, 129, 131], which is already adapted and employed successfully by other researchers in different settings [3, 43, 51, 54, 81, 145]. We used accept-reject tasks (i.e., 50/50 bets asking participants if they accept or reject a wager), a popular method among loss aversion studies [134], since they are very easy to administer and worked well with our other game elements. Previous studies typically do not provide participants with an outcome of each wager (e.g., participants are only able to learn the outcome of one of their wagers and only at the end of the studies), but this is an infeasible approach for a game, so our studies include the player learning the outcomes of each wager they decide to accept. We designed the game to avoid strong influence of earlier outcomes in two ways: first, participants have to battle and earn money before engaging in a new wager, which means that the memory of the previous outcome is not immediate, and that the gold earned from fighting monsters in the new level offsets the feeling that a previous win is a "windfall gain". Second, players always enter a new decision point with more money than they had in the previous one (whether or not they decided to gamble), reducing the likelihood that they will feel the need to make up for a previous loss.

The trickster's treasure chest sets up a wager with 50% chance of both winning and losing, and each wager has different win and loss amounts that can be either favorable (i.e., win more than lose) or unfavorable (lose

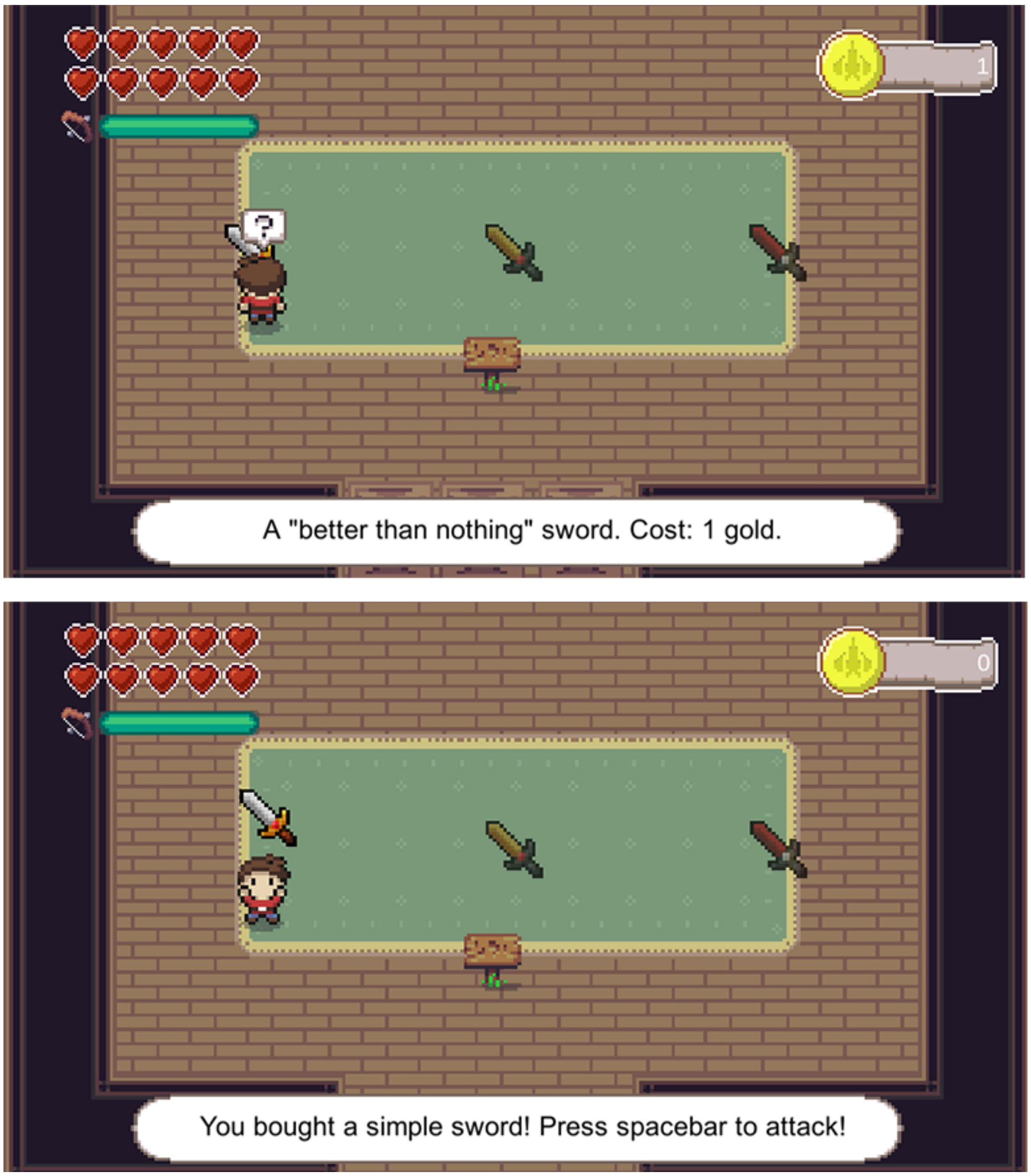

Figure 3.10: Top: player checking the starter sword. Bottom: player buying the starter sword.

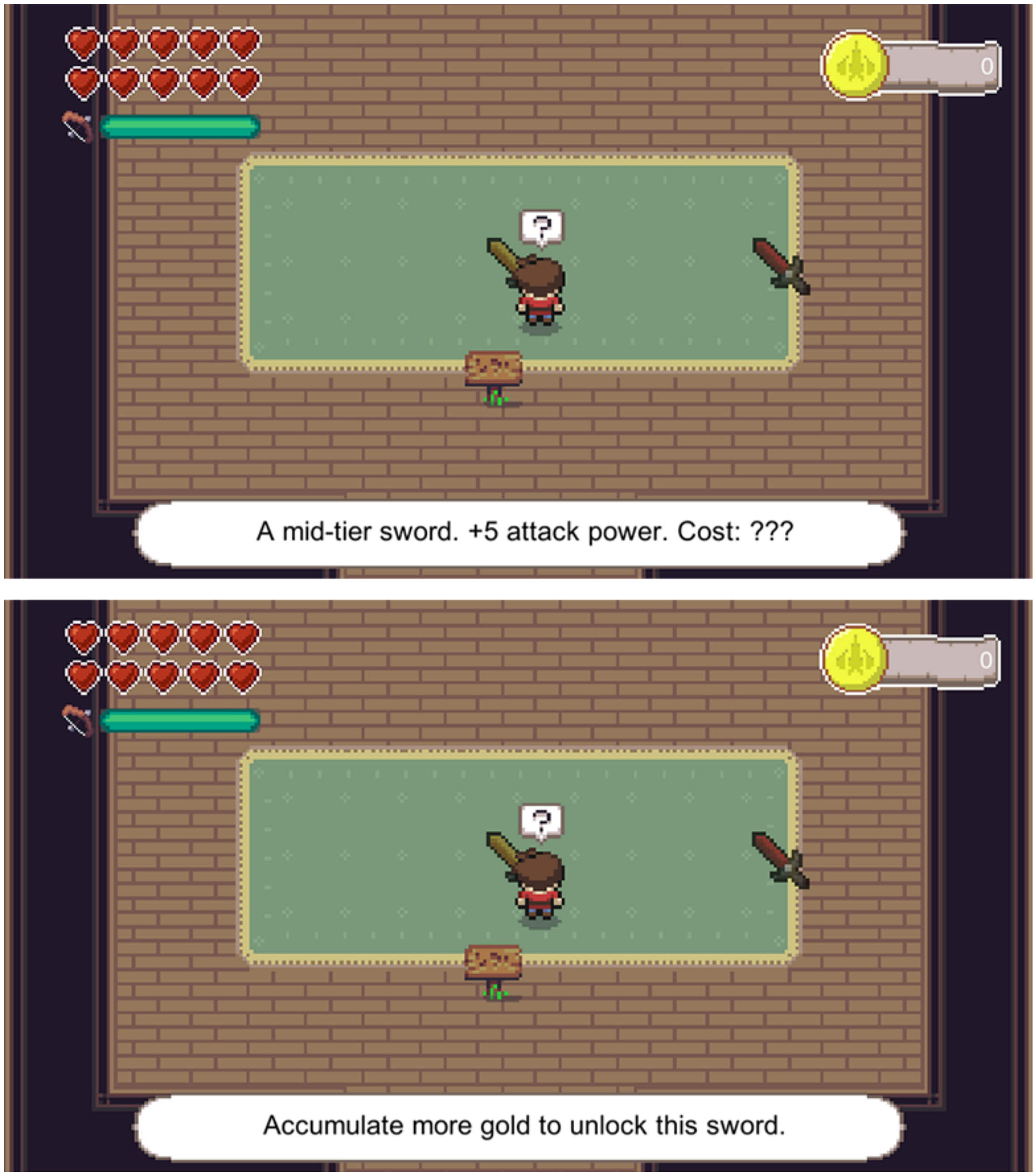

Figure 3.11: Top: player checking the mid-tier sword. Bottom: player trying to buy the mid-tier sword.

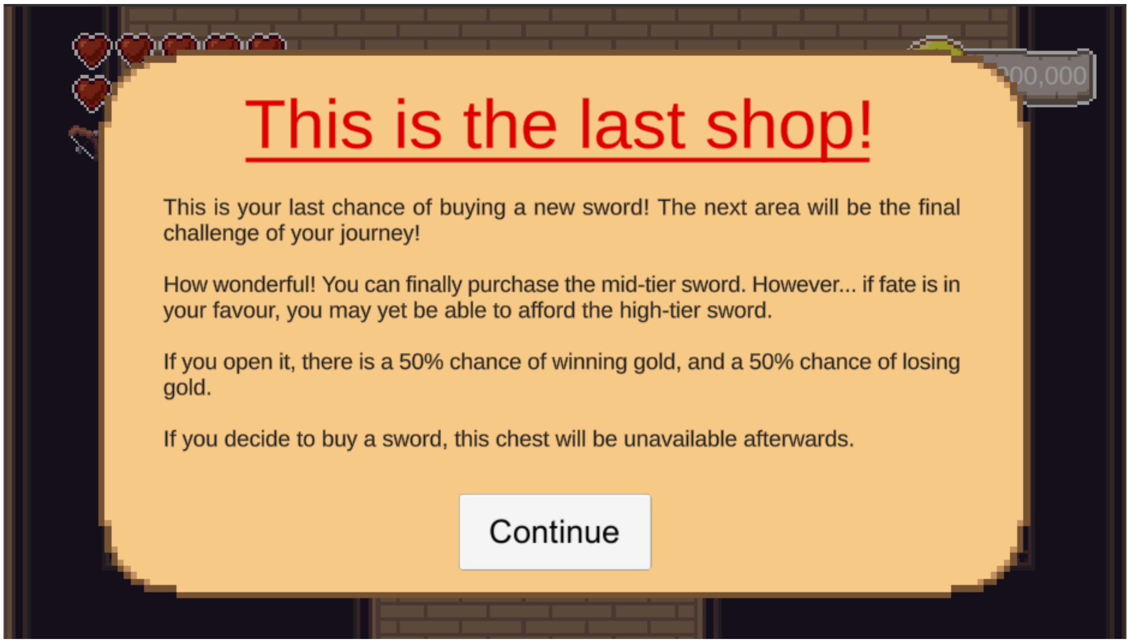

Figure 3.12: Prompt in the game warning players that this is their final chance to wager and buy a sword.

Figure 3.13: Prompt in the game warning players that they are leaving without buying a sword.

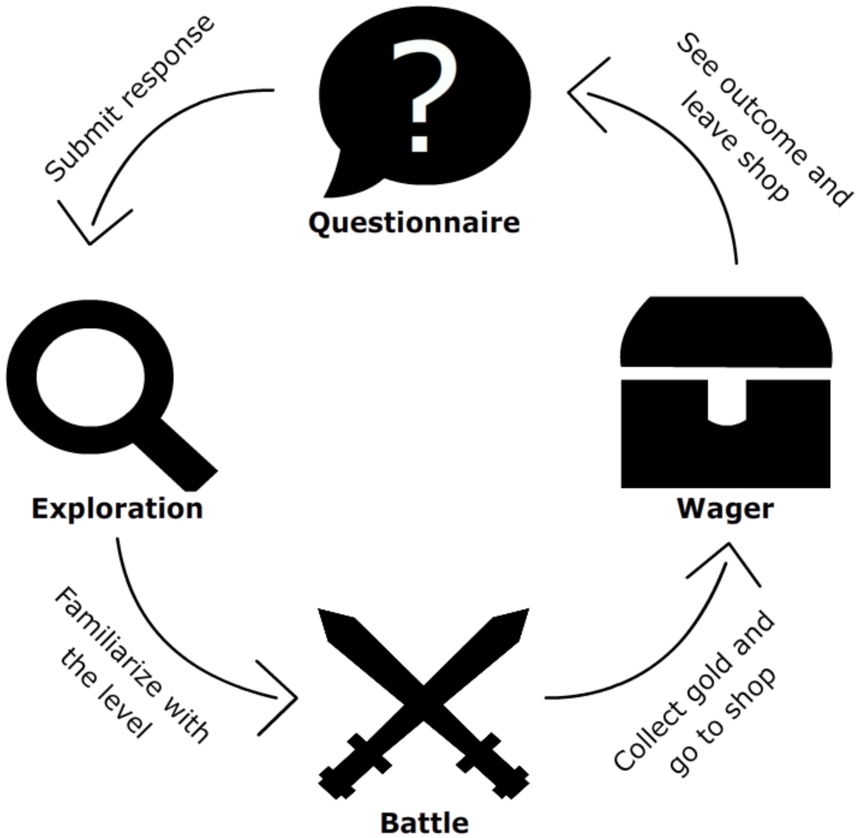

Figure 3.14: Game loop.

more than win). By tracking the number of players who accept each wager, we can look for the presence of loss aversion by examining the rate at which people take different wagers, and by comparing the rate of refusing unfavorable wagers to the rate of accepting equivalent favorable wagers. For example, if 80% of players refuse a win:loss ratio of 0.25 (e.g., win 250, lose 1000) but only 50% accept a ratio of 4.0 (e.g., win 1000, lose 250), people are biased towards avoiding losses. Due to the hedonic nature of games and how short the game used in the studies is, it is not clear if players are going to give the same degree of importance to this virtual currency as they do with real currency in other contexts, so the question if most players are going to reject obvious unfavorable wagers is still an open subject.

3.4.1 Wager Outcomes

The wagers embodied by the trickster's treasure chest provided five different win:loss ratios in Experiment 1, and nine different win:loss ratios in Experiment 2 and 3, each seen twice – once in the first half of the game, and once in the second half – which meant that each ratio was seen with a lower amount and a higher amount. The only exception to the previous statement was the odds ratio 1.25 in Experiment 2, which was presented only in the second half of the game. The outcomes of the accepted wagers were the same for all participants, to increase control over the scenario. The potential losses were fixed at 50% of the player's current wealth in Experiment 1 and Experiment 3, in order to:

- Make wagers feel substantial;
- Enable game procession in a controlled fashion regardless of wager outcome;
- Avoid scenarios where people are reluctant to engage in risks that could result in them losing everything.

Ratios and outcomes of the game's wagers for Experiment 1, Experiment 2, and Experiment 3 are shown in Table 3.1, Table 3.2, and Table 3.3, respectively.

As shown in the tables, the player's wealth before wagers increased at each round. We ensured that all players had the same amount of gold when entering shops by manipulating the value of the treasure chest that they opened after defeating all monsters from a level (players were unaware of this manipulation).

Table 3.1: Wager details for Experiment 1, at each decision point.

Decision	Starting Wealth	Win:Loss	Ratio	Outcome
1	50	25:25	1.0	Loss
2	200	75:100	0.75	Win
3	700	525:350	1.5	Win
4	2000	500:1000	0.5	Loss
5	3500	3500:1750	2.0	Loss
6	5300	1325:2650	0.5	Win
7	9500	7125:4750	1.5	Loss
8	14,800	14,800:7400	2.0	Win
9	40,000	15,000:20,000	0.75	Loss
10	50,000	25,000:25,000	1.0	Win

Table 3.2: Wager details for Experiment 2, at each decision point.

Decision	Starting Wealth	Win:Loss	Ratio	Outcome
1	50	25:25	1.0	Loss
2	200	100:125	0.8	Win
3	500	375:250	1.5	Loss
4	1200	1200:300	4.0	Loss
5	2000	1000:1500	0.667	Win
6	3800	3800:1900	2.0	Loss
7	5000	1250:5000	0.25	Win
8	8200	3075:2050	1.5	Loss
9	10,000	5000:10,000	0.5	Win
10	18,000	9000:13,500	0.667	Loss
11	22,000	14,668:3667	4.0	Win
12	40,000	20,000:10,000	2.0	Loss
13	65,000	16,250:65,000	0.25	Win
14	90,000	45,000:56,250	0.8	Loss
15	105,000	393,750:315,000	1.25	Win
16	520,000	260,000:520,000	0.5	Win
17	820,000	512,000:410000	1.25	Loss
18	1,000,000	500,000:500,000	1.0	Win

Table 3.3: Wager details for Experiment 3, at each decision point.

Decision	Starting Wealth	Win:Loss	Ratio	Outcome
1	50	25:25	1.0	Loss
2	200	80:100	0.8	Win
3	500	375:250	1.5	Loss
4	1200	2400:600	4.0	Loss
5	2000	666.67:1000	0.667	Win
6	3800	3800:1900	2.0	Loss
7	5000	625:2500	0.25	Win
8	8200	5125:4100	1.25	Loss
9	10,000	2500:5000	0.5	Win
10	18,000	6000:9000	0.667	Loss
11	22,000	44000:11000	4.0	Win
12	70,000	70000:35000	2.0	Loss
13	80,000	10000:40000	0.25	Win
14	100,000	40000:50000	0.8	Loss
15	150,000	93750:75000	1.25	Win
16	520,000	130000:260000	0.5	Win
17	820,000	615000:410000	1.5	Loss
18	1,000,000	500000:500000	1.0	Win

3.5 Measures

We made players decide if they wanted to wager their in-game money in certain locations of the game to measure loss aversion, presenting situations where they could win more money than they would lose, and vice-versa. We then analyzed this data using paired Wilcoxon rank sum tests (two-tailed) on pairs of equivalent wagers. "Equivalent wagers" are pairs of bets that are an equal distance from the win:loss ratio of 1.0 (where the player had 50% of chance of winning or losing the same amount). For example, our pairs of equivalent win:loss ratios in Experiment 3 are 0.25 and 4.0, 0.5 and 2.0, 0.6667 and 1.5, and 0.8 and 1.25. We compared each pair of equivalent wagers to check the degree of which players accepted or denied favorable (e.g., 4.0) and unfavorable (e.g., 0.25) wagers in each experiment.

Secondary measures are presented as follow, with the social-demographic survey being presented before the game, the subjective satisfaction measure being presented during the game, and the others surveys presented after the game, in the same order they are presented in this section.

3.5.1 Demographic Measures

Participants filled a survey at the start of the studies that asked information regarding their gender and age, since previous literature suggests that gender and age are a significant factor when assessing loss aversion [93, 29, 45]. They were also asked about their player type, with the options available taken from the BrainHex list of player archetypes [94], which is a neurobiological gamer typology survey, that describes seven player archetypes: Seeker (curious players that mainly enjoy discovering about what a game world has to offer), Survivor (players that mainly enjoy the state of frightening and controlled experiences of panic that games can provide), Daredevil (players that mainly enjoy the excitement and thrill of the chase that games can offer), Mastermind (players that mainly enjoy solving puzzles and discovering strategies to overcome obstacles), Conqueror (players that mainly enjoy the feeling of winning and overcoming adversaries after struggling through adversity), Socializer (players that mainly enjoy creating social connections while gaming), Achiever (players that mainly enjoy overcoming long-term achievements and explicit goals).

3.5.2 Subjective Satisfaction Measure

During level transitions (as to not interrupt gameplay and affect the player experience), players rated their satisfaction with their own progress through the game (See Figure 3.1). We asked this question at the start of a following level to avoid players responding only in terms of their previous wager results.

3.5.3 Attitudes Toward Gold Questions

Participants reported on their attitudes toward gold in the game through a series of "yes" or "no" questions, followed by an open-ended question asking for clarification on the previous answer. Our expectation was that most players would reflect a degree of hedonic or utilitarian value.

3.5.4 Problem Gambling Severity Index (PGSI)

We asked participants about their problem gambling severity using the Problem Gambling Severity Index (PGSI, [66]), a tool used to assess risk behavior in problem gambling, which is a 9-item scale that categorizes respondents as non-problem (0 points in total), low-risk (1-2), moderate-risk (3-7), or high-risk (8+) gamblers. We used the data from this scale to verify if people with different degrees of gambling propensity would behave differently in our game based on their gambling propensity profile.

3.6 Procedure

We used Amazon's Mechanical Turk (MTurk) crowdsourcing platform to recruit participants for the studies. MTurk has been shown to be a reliable tool for HCI and games user research [20, 28, 38], with many researchers showing that it is at least as reliable as data obtained from traditional methods [30, 63, 80, 100], including when collecting behavioral/decision-making data [48, 67, 90, 99]. We obtained ethical approval from the behavioral research ethics board at University of Saskatchewan, and participants were asked to give their consent to proceed to the experiment. The task was only available to USA workers older than 18 years old to comply with ethical guidelines, and they had to have an approval rate above 90% for quality control reasons. The studies was conducted in two phases: a screening session, and an experiment session.

3.6.1 Screening

We conducted a screening for Experiment 2 and 3, to avoid participants not being able to complete the experiments in a timely manner due to unfamiliarity with 2D action-adventure games. The screening consisted of a tutorial level where participants played a longer version of the first level of the game, which ended before the first decision point. Participants were informed that the screening had an estimated completion time between five to ten minutes, and that participation in a follow-up study was based on performance in the game. Participants that finished the tutorial level in less than 10 minutes were invited to participate in the game experiment, whereas the game would finish automatically if a participant spent more than 10 minutes on it. All participants were paid $0.70 regardless of the circumstances that the game finished.

3.6.2 Experiment Session

Participants were informed about the estimated time to complete the study (60 min) and how much they would be paid (US $10) at the start of the study. They were sent to the game after filling the demographics survey, in which we collected telemetry data regarding their choices and subjective satisfaction. After finishing the game, participants were asked to fill the previously mentioned surveys regarding their attitude toward gold, and problem gambling severity.

4 Results for Experiment 1

4.1 Participants

A total of 109 participants finished Experiment 1. After excluding participants who failed to provide answers to surveys (2 people, e.g., participant that wrote "I LIKE THE GAME" in all form fields, or other types of nonsense), figured out the manipulation earlier in the game (4 people, i.e., realized that the outcomes were not random at the start of the game), or selected survey items faster than 1.5 sec/item [28] (19 people, i.e., careless responders or bots), we ended with a total of 84 participants: 49 men, 34 women, one non-binary; ages 21-68 (mean 9.11); playing 0-40 hours of videogames per week (mean 7.98). All participants were familiar with desktop and mobile apps, and most chose PC as their favorite platform (55%), followed by console (20%) and mobile (20%). Participants self-identified as Achiever (37%), Seeker (31%), Mastermind (9%), Conqueror (9%), Survivor (5%), Socializer (3%), or Daredevil (3%).

4.2 Did Loss Aversion Occur in the Game?

Of the 84 players, 78 wagered at least once during the 10 rounds of the game, and the average number of wagers accepted per player was 4.6 (46.5%). As can be seen from Figure 4.1, willingness to accept unfavorable wagers is low, but increases as the win:loss ratio improves, reaching approximately 50% when the ratio reaches 1.0. At favorable wagers (where players stood to win more than they lost), people were more willing to accept a wager, but acceptance rate did not surpassed 70%.

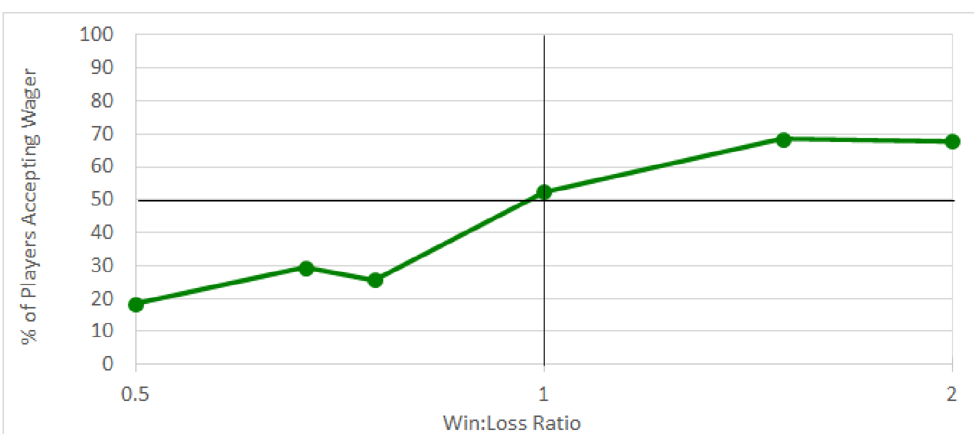

Figure 4.1: Overall acceptance of wagers by win:loss ratio, in Experiment 1.

To look for loss aversion, we compared the rate at which players accepted and declined equivalent favorable and unfavorable wagers. The pair of equivalent win:loss ratios for Experiment 1 is 0.5 and 2.0, but we also consider the pair 0.75 and 1.5 in this and the other analysis, despite them not exactly fitting the definition (see Table 3.1 for all corresponding values). Further, by using interpolation, we can predict results for the ratio 0.66, which is the equivalent wager for ratio 1.5.

Comparing the pairs of equivalent wagers shows evidence of loss aversion (see Figure 4.2). If players decline a pair's unfavorable wager more often than they accept the favorable wager, they are loss aversive. We used paired Wilcoxon rank sum tests (two-tailed) to compare the accept/reject rates in each pair. Results are shown in Table 4.1: for the pair 0.5 and 2.0, the difference was significant.

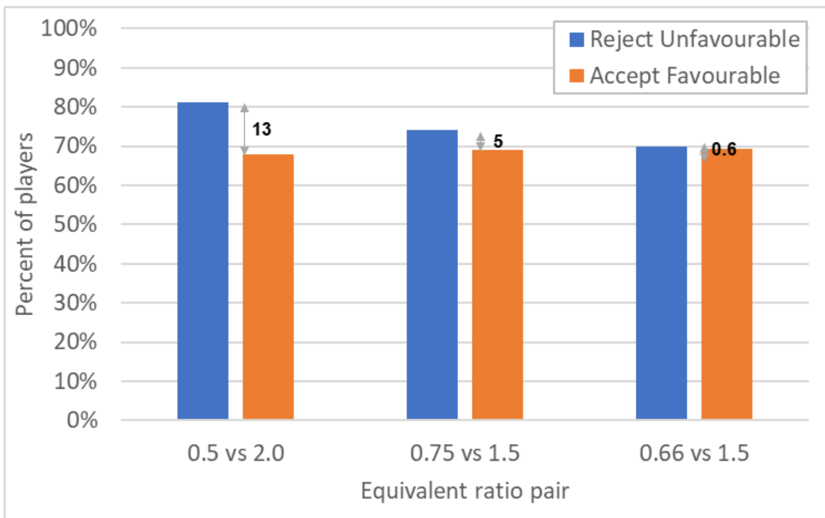

Figure 4.2: Rates of rejecting unfavorable ratios vs. accepting equivalent favorable ratios, in Experiment 1.

Table 4.1: Wilcoxon tests comparing reject rate for unfavorable ratios vs accept rate for favorable ratios, in Experiment 1.

Unfavorable ratio	Reject rate	Favorable ratio	Accept rate	V	p
0.5	81.3%	2.0	68.0%	1800	**<.05**
0.75	74.0%	1.5	69%	2044.5	=.3897
0.66	69.8%	1.5	69.2%	1296	=.9081

4.3 Is Loss Aversion Affected by Wager Amount?

Each win:loss ratio in the game was seen by players twice: once at a lower amount and once at a higher amount (see Table 3.1, 3.2, and 3.3). We grouped these into two categories (Low and High) for further analysis, including interpolated data at ratio 0.66. Low wagers were accepted more often (48.33% of the time overall) than High wagers (39% overall); see Figure 4.3.

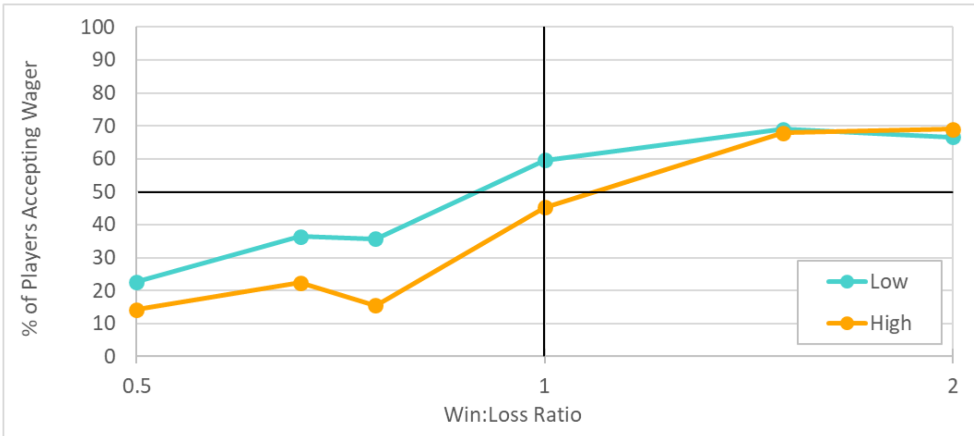

Figure 4.3: Acceptance of wagers by amount of the wager, in Experiment 1.

We carried out a similar analysis of equivalent wagers for Low and High amounts. These data are shown in Figure 4.4, and Wilcoxon rank sum tests (two-tailed) are reported in Table 4.2. The results show that loss aversion was evident for High amounts, but not for Low amounts, especially for the pairs 0.75/0.66 and 1.5.

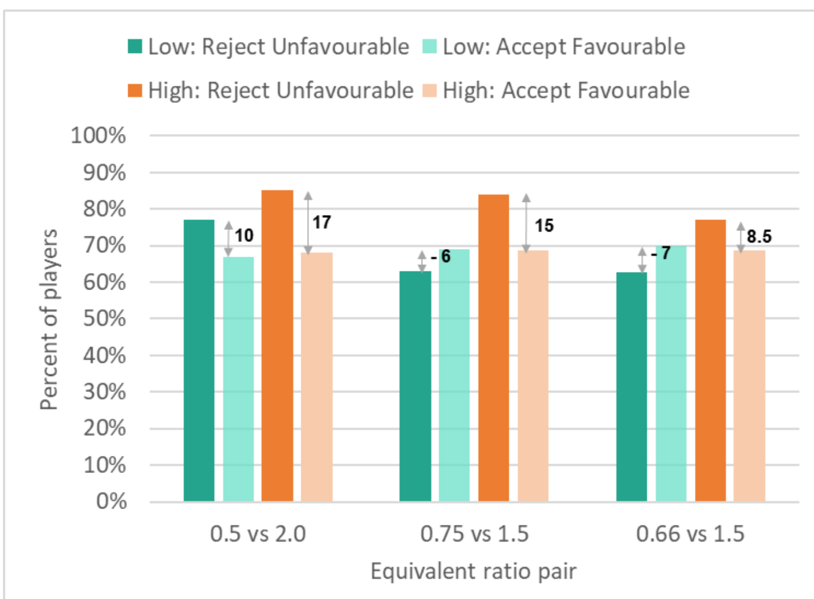

Figure 4.4: Rates of rejecting unfavorable ratios vs. accepting equivalent favorable ratios by wager amount, in Experiment 1.

Table 4.2: Wilcoxon tests comparing reject rate for unfavorable ratios vs accept rate for favorable ratios by amount of wager, in Experiment 1.

Unfavorable ratio	Reject rate	Favorable ratio	Accept rate	V	p
		Low Amounts			
0.5	77%	2.0	67%	407	=.1854
0.75	63%	1.5	69%	504	=.4695
0.66	62.6%	1.5	69.8%	277.5	=.3217
		High Amounts			
0.5	85%	2.0	68%	507	**<.05**
0.75	84%	1.5	68.6%	520	**<.05**
0.66	77.1%	1.5	68.6%	374	=.2405

4.4 Does Loss Aversion Change Across Player Groups?

We examined whether there were differences arising from several intrinsic factors in our players, including gender, age, player type, and gambling propensity. We note that because we cannot carry out multi-factor analyses to look for interactions, our analysis first considers overall differences in willingness to wager, and then considers possible differences in loss aversion through simple inspection.

4.4.1 Effect of Gender

In total, 83 of 84 players identified as either "woman" or "man" in our demographic questionnaire. Including the interpolated data at ratio 0.66, overall women accepted 37% of the 10 wagers, and men 49.%. Wilcoxon tests comparing willingness to accept wagers showed a significant effect of gender at ratios 1.5 and 2.0 ($p<0.0001$). Figure 4.5 shows the proportion of men and women who accepted wagers at each win:loss ratio. To look for differences in loss aversion, we carried out a similar comparison of equivalent wagers for the two genders: results are shown in Figure 4.6. Wilcoxon tests indicated that, with the exception of pairs 0.5 and 2.0 ($p=.8699$) and 0.66 and 1.5 ($p=.1306$) for Men, all differences between reject-unfavorable and accept-favorable were significant at $p<0.05$. As can be seen in Figure 4.6, the difference between rejecting unfavorable wagers and accepting favorable ones was considerable higher for women than for men, suggesting that women were more loss averse than men.

4.4.2 Effect of Age

We grouped our participants into five categories: 19-25 (7 people, 45% of the 10 wagers accepted); 26-35 (29 people, 43%); 36-45 (32 people, 47%); and over 45 (16 people, 37%). Figure 4.7 shows these age groups' willingness to accept wagers at each win:loss ratio, included the interpolated ratio 0.66. Kruskal-Wallis tests

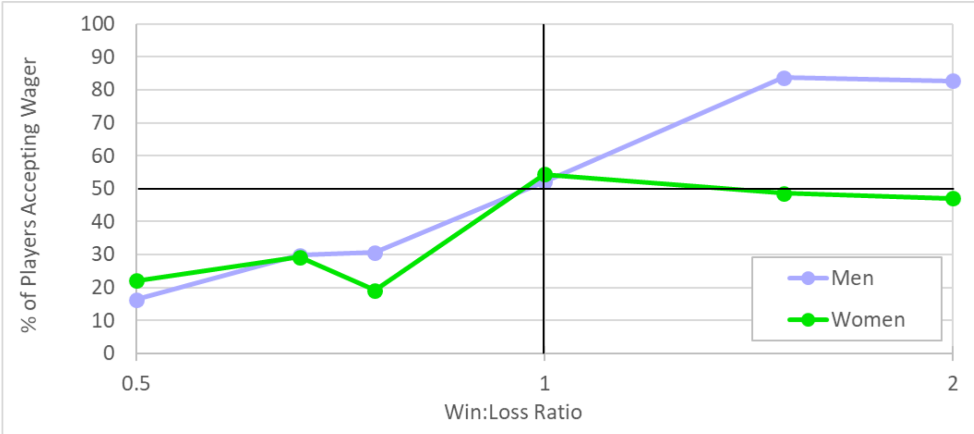

Figure 4.5: Acceptance of wagers by gender, in Experiment 1.

(Bonferroni-corrected) [2], a non-parametric alternative to a one-way ANOVA, were performed at each ratio showed only one significant difference by age group (at ratio 1.5, p= 0.02451, see Figure 4.7); for all other ratios, p>0.05. There was also no clear evidence of difference in loss aversion, but the difference at ratio 1.5 may suggest a trend for players over 45 to be more loss-aversive than players under 45.

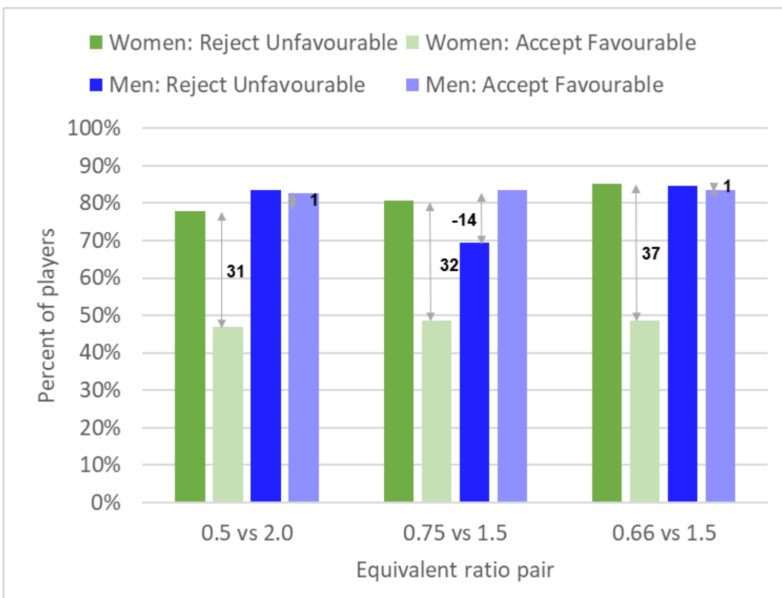

Figure 4.6: Rates of rejecting unfavorable ratios vs. accepting equivalent favorable ratios by gender, in Experiment 1.

4.4.3 Effect of Gambling Propensity

Participants completed the PGSI questionnaire to estimate their gambling propensity [66], with participants categorized as non-problematic (63 people, accepted 40% of the 10 wagers), low-risk (10 people, 54%) moderate-risk (9 people, 46%), and high-risk gamblers (2 people, 89%), including the interpolated ratio 0.66.

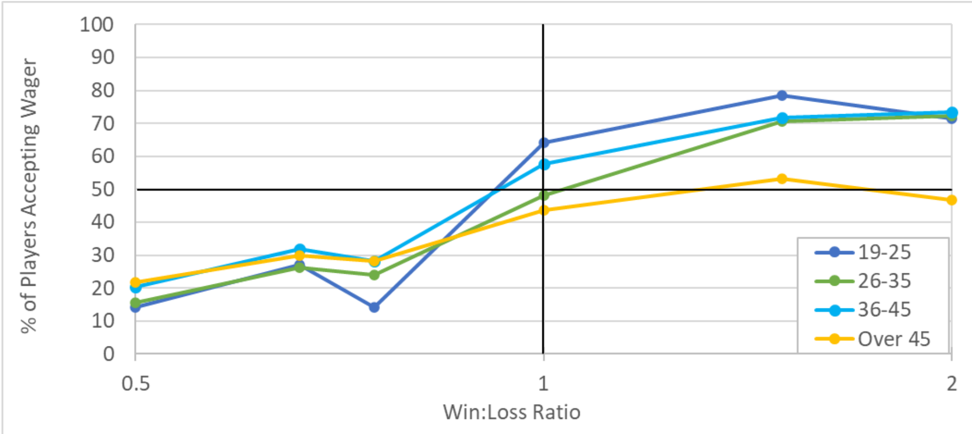

Figure 4.7: Acceptance of wagers by age group, in Experiment 1.

Bonferroni corrected Kruskal-Wallis tests at each ratio showed an effect of PGSI risk group on willingness to wager at ratios 0.5 and 0.66 ($p=0.03662$ and $p=0.0167$ respectively, see Figure 4.8), however, as there were only 2 players in this group, a larger sample is needed for further investigation of this issue.

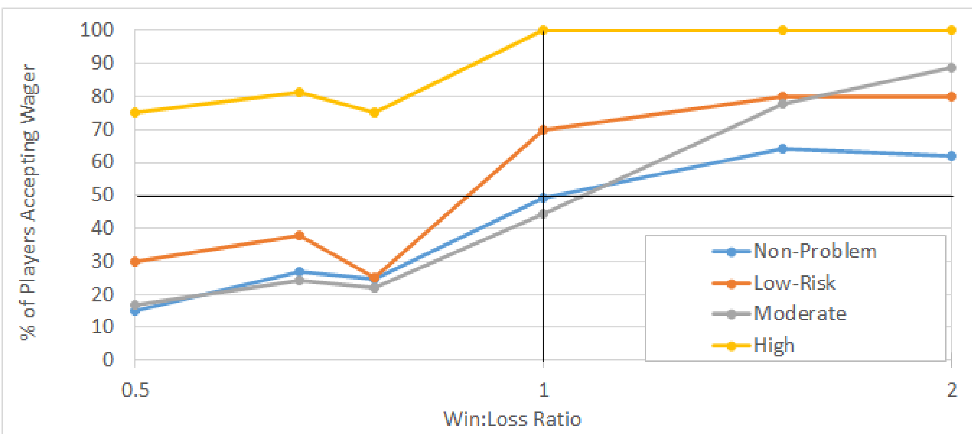

Figure 4.8: Acceptance of wagers by gambling risk group, in Experiment 1.

4.4.4 Effect of Player Type

We asked players to self-identify as one of the player types in the BrainHex model (see Section 3.5.1 for more details) [94]. Participants chose Achiever (31 people, accepted 39% of the 10 wagers), Seeker (26 people, 44%), Conqueror (8 people, 54%), Mastermind (8 people, 46%), Survivor (4 people, 31%), Socializer (3 people, 45%), and Daredevil (3 people, 66%). Kruskal-Wallis tests at each ratio (included the interpolated ratio 0.66) showed no effect of player type on willingness to wager (all $p>0.05$). In addition, the data show no clear evidence of any differences in loss aversion by player type (see Figure 4.9).

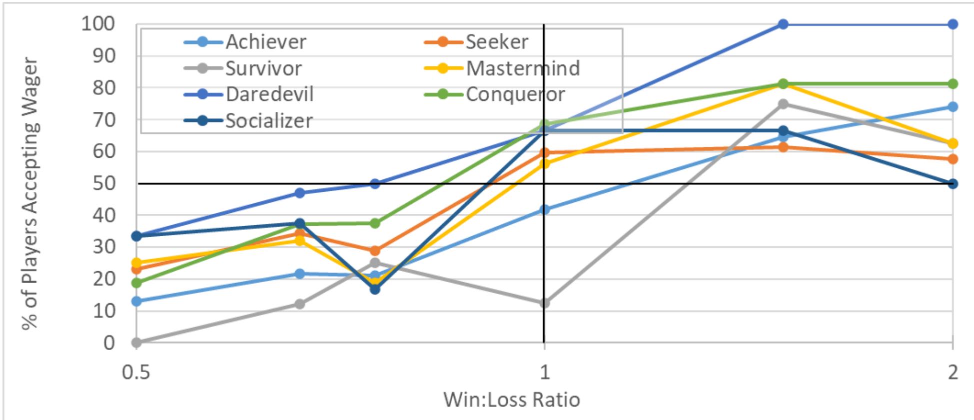

Figure 4.9: Acceptance of wagers by player type, in Experiment 1.

4.5 Player Attitudes Toward Gold in the Game

4.5.1 Attachment to the Gold

Half of participants selected that they felt attached to their gold, with the most common reason being that they wanted to use it to buy the sword upgrade, followed by attachment due to the effort they had to earn it: "I worked hard for the gold I didn't want to lose or gamble it needlessly"(P27). Further, some participants expressed feeling more attached to their gold after a lost: "Whenever I lost gold I felt really bad because it seemed I was so much farther from a sword upgrade than I was before." (P3).

As for the other half of participants that did not get attached to their gold, many of them highlighted how easy it was to collect gold, as well as the limited purchase options, which in turn decreased the purpose of collecting it. "I couldn't spend it on anything so it started to feel like 'points' to me.", said P49.

4.5.2 Purchasing Power

Sixty-four participants (76%) felt that the gold in the game had purchasing power. As for the main reason, the possibility of buying the sword upgrades came on top, with 77% of the responses. However, some participants mentioned that gold only had purchasing power at the end of the game, and were frustrated that nothing could be bought with it in the meantime. "I felt it did but it was frustrating that I couldn't buy a sword until the very last level before the final wave.", said P18. One participant mentioned that getting the first sword for 1 gold made the money seem tangible, and another one specified that the value of gold grew as the game got more difficult: "The money grew in value in the tougher areas, so the ability to purchase a good sword felt like it was drawing closer and closer."(P60).

Twenty participants (24%) did not felt that the gold had purchasing power, many of them feeling upset that they could not buy anything until the end of the game. The cost of the swords being hidden coupled with the high cost when it was revealed where also concerns mentioned more than once: "I don't get why we had to go through so many shops if we couldn't afford a sword til the end or almost the end anyway" (P47).

4.5.3 Saving Money for an Upgrade

Eighty-one participants (96%) were hoping to save enough money to buy the sword upgrades, with many of them assuming that buying the swords was the main goal of the game ("It felt like that was what the game was building towards.", said P44). Reasons for wanting a better sword include:

- To make the game easier;
- To defeat enemies faster;
- To progress in the game faster.

Some participants also mentioned buying the swords as a form of achievement: "I felt like the game would be easier and it would be an achievement to purchase a better sword", said P45).

The reasons that three participants (4%) were not hoping to save enough money to buy the sword upgrades were:

- Lack of interest on buying a new sword;
- Having no idea how much a sword would cost;
- Disinterest in the game.

4.5.4 Avoiding the Trickster's Treasure Chest

Seventy-eight participants (93%) avoided using the trickster treasure chest (i.e., wagering) at any point. The most common response was unfavorable odds, which were commonly framed as "bad odds/gamble", "imbalanced/unfair odds", "low payoff", and "too risky". The second most common reason was "fear of losing money", with no more details. One possible explanation for this fear is that, since a great number of players assumed that buying the swords was the main goal of the game, losing money would be the same as losing progress. Some participants even stopped wagering when they were close to reach their goal, but interestingly, there were cases of the inverse situation happening as well, with participants only feeling comfortable to wager when they had collected a considerable amount of money: "When I opened the chest I avoided the chances until I had a decent amount of money in case I lost." (P35). Despite the presence of mechanisms to decrease the effects of previous losses in following wagers, around 10% of participants where impacted by it. "After a big loss, I would decide to avoid the chest until I felt lucky enough to try it again.", said P42.

The reasons that six participants (7%) did not avoided using the trickster treasure chest any point were:

- Wanted to afford the sword upgrades;

- Was in the mood for gambling;
- Felt an urge to gamble.

Our question was not clear for two participants, which responded in terms of checking the treasure chest ("I had to go open it in order to open the door out, so I couldn't avoid it.", said P24), and one participant did not gave a reason for not avoiding a wager, but highlighted that they almost decided to not wager in the last wager ("On the last chest, I almost decided to avoid the treasure just to make sure I could afford the less powerful sword. In the end I decided to take the risk for the better sword and won.", said P17).

4.6 Player Satisfaction

As a second analysis of loss aversiveness, we looked at player responses to the question "How satisfied are you with your progress?" that was given after the player had interacted with the shopkeeper (and if they had taken the wager, after the outcome was revealed). There were an equal number of wins and losses at different win:loss ratios (pre-determined, as outlined earlier), and we assessed the influence of losing and winning on perceived progress by comparing responses to those of people who did not bet. Figure 4.10 shows the results: a loss led to a reduction of 0.48 on the 5-point perceived-progress scale, whereas a win only led to an increase of 0.1. This result suggests that the effect of a loss was larger than the effect of a win – in line with previous work suggesting that "losses loom larger than gains."

4.7 Interpretation of Results

Our analysis showed strong evidence of loss aversion with participants from Experiment 1, with low wagers being accepted more often than high wagers, women being more averse to loss than men, and losses having a greater impact on players' satisfaction than gains. We did not find conclusive evidence of effects of age, gambling propensity, and player type in willingness to accept a wager.

Despite only half of participants expressing that they felt attached to our game currency, the responses from our open-ended survey indicate that we had success with introducing sword upgrades as a way to give utility to our game currency, with the majority of participants wanting to save money for the sword upgrade, and feeling that the game currency had purchasing power. The majority of participants also avoided wagering at least once in the game, with the most common response being that it was not worth to wager when the amount of gold they could lose was higher than the amount they could win.

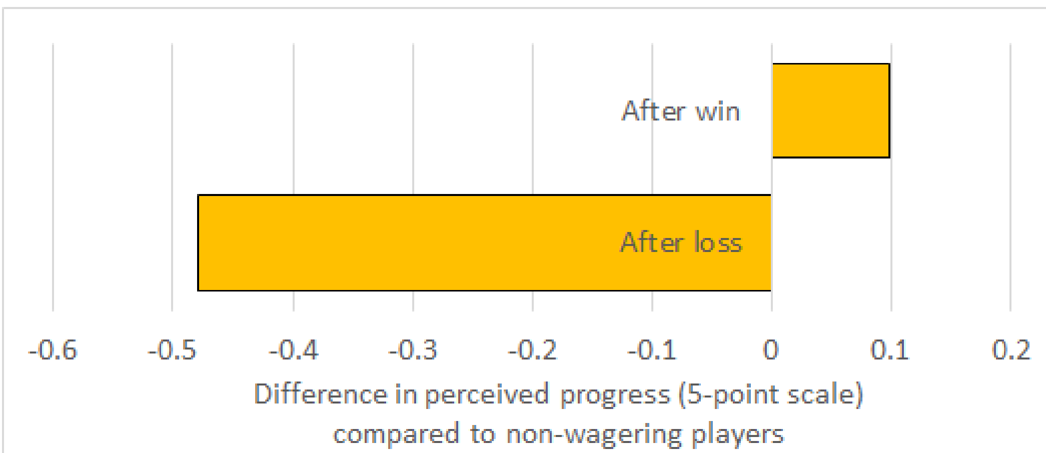

Figure 4.10: Relative change in perceived satisfaction after a win or a loss in Experiment 1, compared to players who did not wager.

5 Results for Experiment 2

We decided to develop Experiment 2 to address the following issues from Experiment 1:

- Low number of data points;
- Not all pairs being equivalent wagers.

By addressing these issues, we hoped to strengthen our findings regarding loss aversion. We also decided to test the effects of loss aversion by creating situations where players could lose all their money, but only theoretically since the outcomes for these wagers were always a win.

5.1 Participants

A total of 120 participants finished Experiment 2. After excluding participants (we used exclusion criteria similar to what was used on Section 4.1) who failed to provide answers to surveys (1 people), selected survey items faster than 1.5 sec/item (6 people, we ended with a total of 113 participants: 77 men, 36 women; ages 22-68 (mean 8.97); playing 0-50 hours of videogames per week (mean 8.68). All participants were familiar with desktop and mobile apps, and most chose PC as their favorite platform (45%), followed by console (32%) and mobile (18%). Participants self-identified as Achiever (34%), Seeker (22%), Mastermind (15%), Socializer (9%), Survivor (9%), Daredevil (5%), or Conqueror (4%).

5.2 Did Loss Aversion Occur in the Game?

Of the 113 players, all of them wagered at least once during the 18 rounds of the game, and the average number of wagers accepted per player was 7.6 (42.5%). As can be seen from Figure 5.1, willingness to accept unfavorable wagers is low, but increases as the win:loss ratio improves, reaching approximately 50% when the ratio reaches 1.0. At favorable wagers, results show a step decrease in wager acceptance at 1.25, followed by an increase starting at ratio 1.5 onward.

As with the previous experiment, to look for loss aversion we compared the rate at which players accepted and declined equivalent favorable and unfavorable wagers, with our pairs of equivalent win:loss ratios being 0.25 and 4.0, 0.5 and 2.0, 0.6667 and 1.5, and 0.8 and 1.25 (see Table 3.2 for corresponding values). Comparing the pairs of equivalent wagers shows evidence of loss aversion (see Figure 5.2), and Wilcoxon rank sum tests

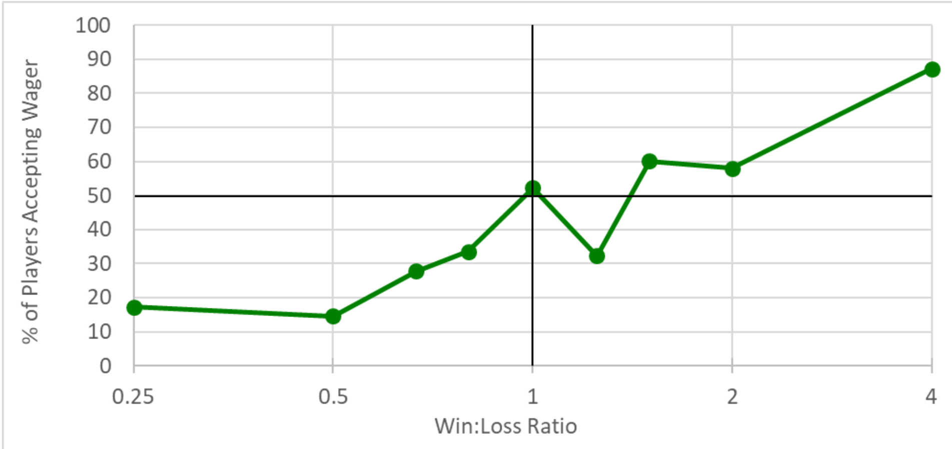

Figure 5.1: Overall acceptance of wagers by win:loss ratio, in Experiment 2.

(two-tailed) comparing the accept/reject rates in each pair show that, except for the pair 0.25 and 4.0, the difference was highly significant (see Table 5.1).

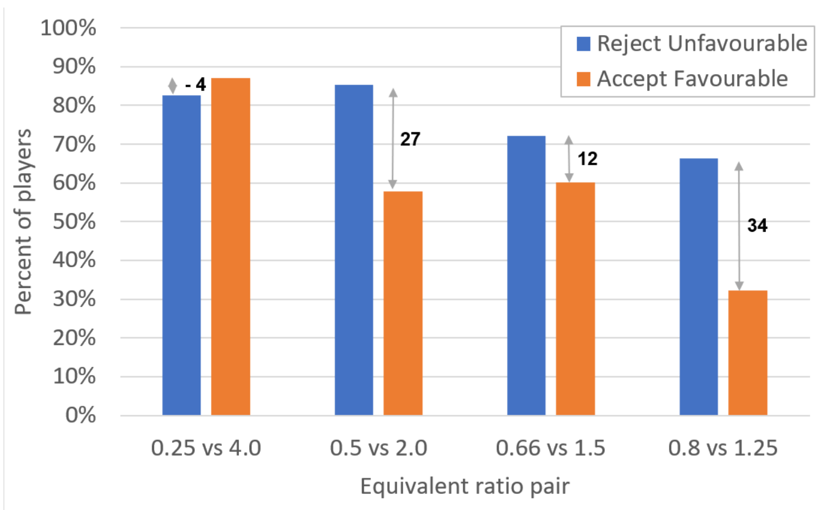

Figure 5.2: Rates of rejecting unfavorable ratios vs. accepting equivalent favorable ratios, in Experiment 2.

5.3 Is Loss Aversion Affected by Wager Amount?

Low wagers were accepted more often (40% of the time overall) than High wagers (30% overall) (see Figure 5.3).

We carried out a similar analysis of equivalent wagers for Low and High amounts (see Figure 5.4), and Wilcoxon rank sum tests (two-tailed) are reported in Table 5.2. The results show that loss aversion was evident for High amounts, but not for Low amounts.

Table 5.1: Wilcoxon tests comparing reject rate for unfavorable ratios vs accept rate for favorable ratios, in Experiment 2.

Unfavorable ratio	Reject rate	Favorable ratio	Accept rate	V	p
0.25	82.7%	4.0	87.1%	708	=.1907
0.5	85.3%	2.0	57.9%	5505	**<.0001**
0.66	72.1%	1.5	60.1%	5070	**<.05**
0.8	66.3%	1.25	32.3%	11,303	**<.0001**

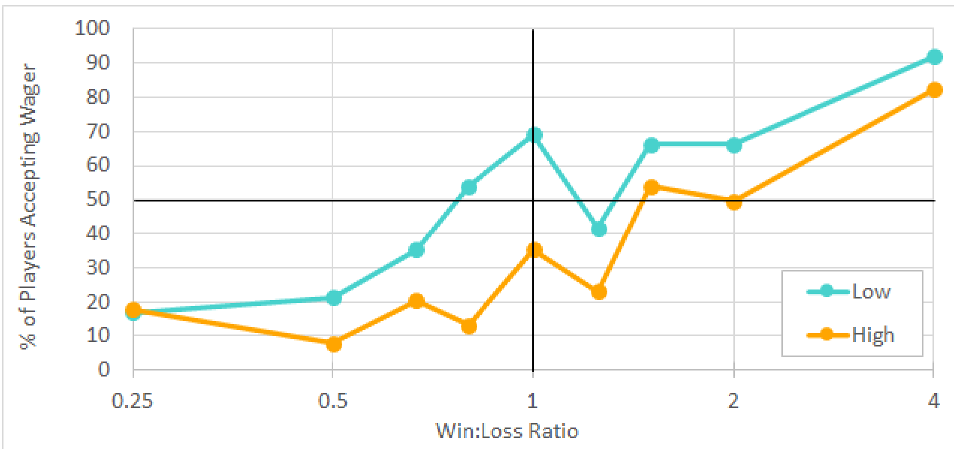

Figure 5.3: Acceptance of wagers by amount of the wager, in Experiment 2.

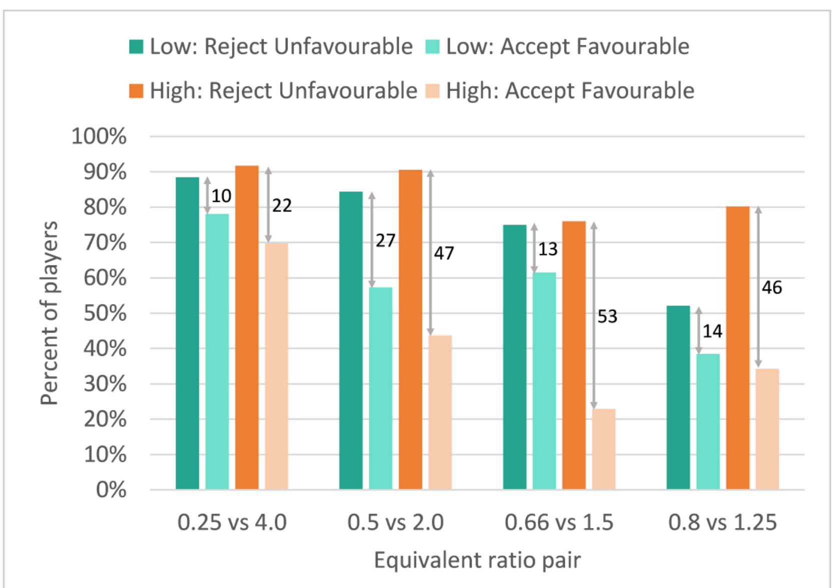

Figure 5.4: Rates of rejecting unfavorable ratios vs. accepting equivalent favorable ratios by wager amount, in Experiment 2.

Table 5.2: Wilcoxon tests comparing reject rate for unfavorable ratios vs accept rate for favorable ratios by amount of wager, in Experiment 2.

Unfavorable ratio	Reject rate	Favorable ratio	Accept rate	V	p
Low Amounts					
0.25	83.1%	4.0	92.0%	130.5	=.06055
0.5	78.7%	2.0	66.3%	997	=.06202
0.66	64.6%	1.5	66.3%	826	=.7963
0.8	46.0%	1.25	41.5%	1935	=.5893
High Amounts					
0.25	82.3%	4.0	82.3%	232.5	=1
0.5	92.0%	2.0	49.5%	1820	**<.0001**
0.66	79.6%	1.5	53.9%	1800	**<.001**
0.8	86.7%	1.25	23.0%	3813	**<.0001**

5.4 Does Loss Aversion Change Across Player Groups?

As with the previous experiment, we note that our analysis of the secondary measures only considers overall differences in willingness to wager due to the impossibility of carrying out multi-factor analysis to look for interactions, followed by analysis of possible differences in loss aversion through simple inspection.

5.4.1 Effect of Gender

All players identified as either "woman" or "man" in our demographic questionnaire. Women accepted 38% of the 18 wagers, and men 45%. Wilcoxon tests comparing willingness to accept wagers showed a significant effect of gender at ratios 1.5, 2.0, and 4.0 ($p<0.05$). Figure 5.5 shows the proportion of men and women who accepted wagers at each win:loss ratio. Results of our analysis of loss aversion by comparing equivalent wagers between the two genders are shown in Figure 5.6. Wilcoxon tests indicated that, with the exception of the pair 0.66 and 1.5 for Men ($p=0.282$) and 0.25 and 4.0 for Women ($p=0.261$), all differences between reject-unfavorable and accept-favorable were significant at $p<0.05$. As can be seen in Figure 5.6, the difference between rejecting unfavorable wagers and accepting favorable ones was, for the most part, higher for women than for men.

5.4.2 Effect of Age

We grouped our participants into five categories: 19-25 (9 people, 54% of the 18 wagers accepted); 26-35 (47 people, 40%); 36-45 (42 people, 46%); and over 45 (15 people, 34%). Kruskal-Wallis tests (Bonferroni-corrected) at each ratio showed no significant difference by age group for all ratios ($p>0.05$, see Figure 5.7), or evidence of difference in loss aversion.

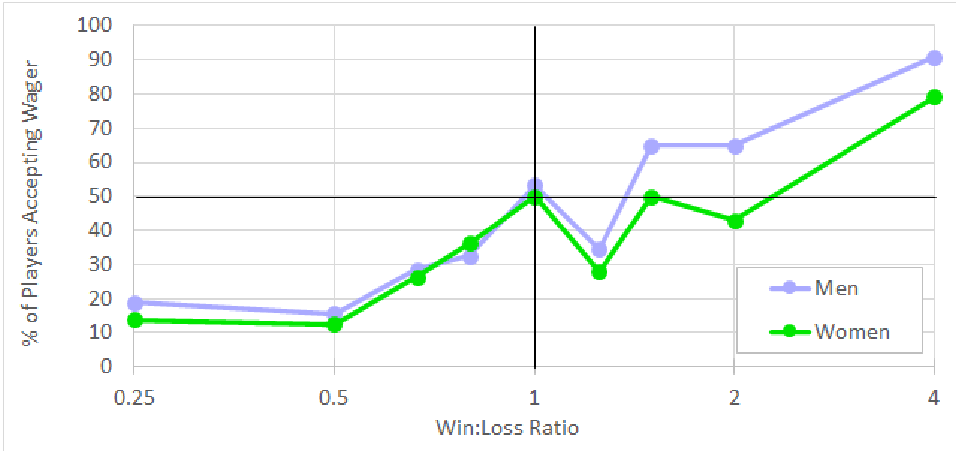

Figure 5.5: Acceptance of wagers by gender, in Experiment 2.

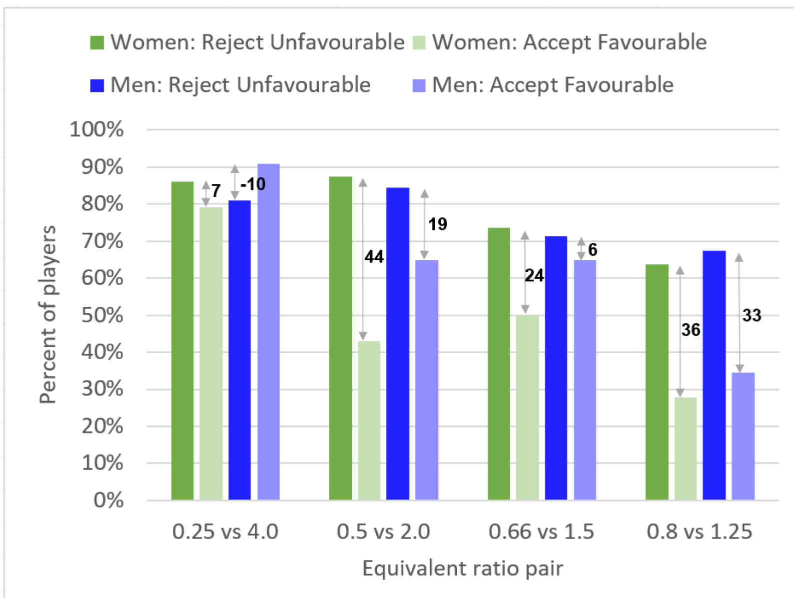

Figure 5.6: Rates of rejecting unfavorable ratios vs. accepting equivalent favorable ratios by gender, in Experiment 2.

5.4.3 Effect of Gambling Propensity

Participants were categorized as non-problematic (71 people, accepted 39% of the 18 wagers), low-risk (23 people, 44%) moderate-risk (11 people, 50%), and high-risk gamblers (8 people, 56%). Bonferroni corrected Kruskal-Wallis tests at each ratio showed an effect of gambling propensity on willingness to wager at ratio 0.5 ($p=0.05023$) and 0.66 ($p=0.05132$), see Figure 5.8. However, we can't draw conclusive evidence from these results as there were only 8 players in this group.

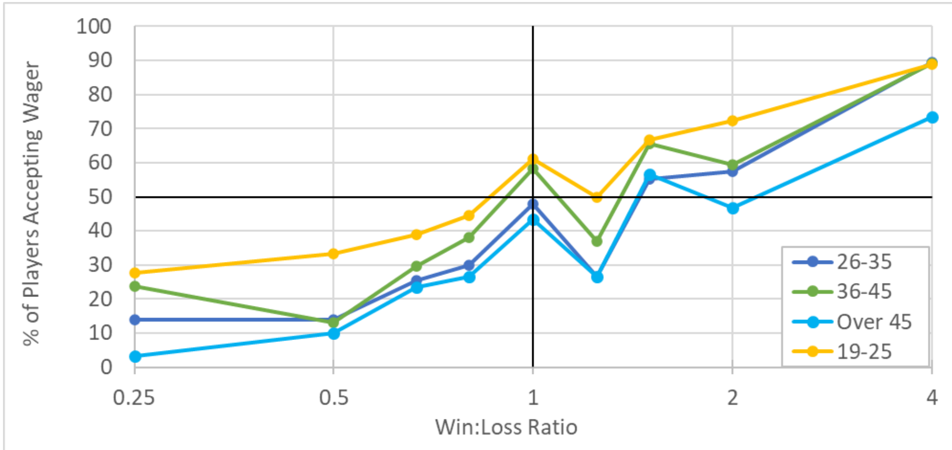

Figure 5.7: Acceptance of wagers by age group, in Experiment 2.

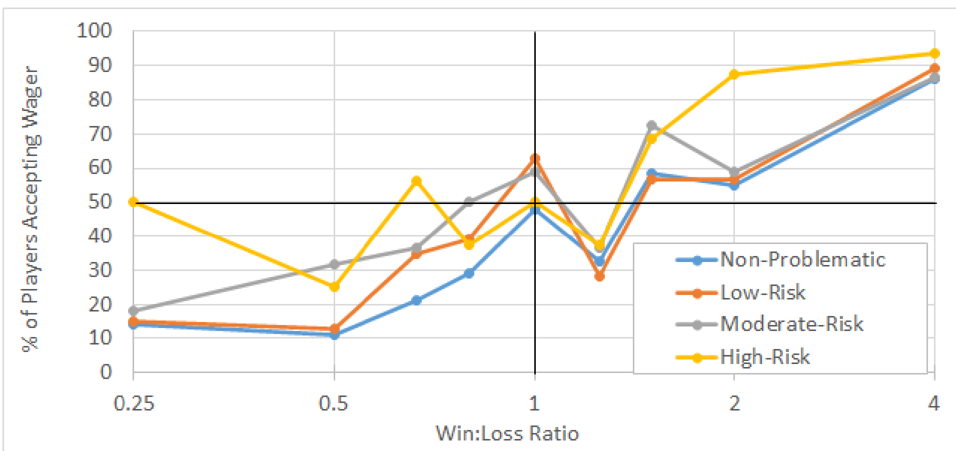

Figure 5.8: Acceptance of wagers by gambling risk group, in Experiment 2.

5.4.4 Effect of Player Type

Using the BrainHex model (see Section 3.5.1 for more details), participants self-identified as Achiever (39 people, accepted 36% of the 18 wagers), Seeker (25 people, 44%), Conqueror (5 people, 38%), Mastermind (17 people, 47%), Survivor (10 people, 34%), Socializer (10 people, 59%), and Daredevil (6 people, 60%).

Kruskal-Wallis tests at each ratio showed an effect of player type on willingness to wager at ratios 0.5 and 0.66 ($p<0.05$), with Figure 5.9 suggesting that players that choose Daredevil and Socializer where less loss averse than the other player type. However, due to the small sample size of each group, more investigation is needed.

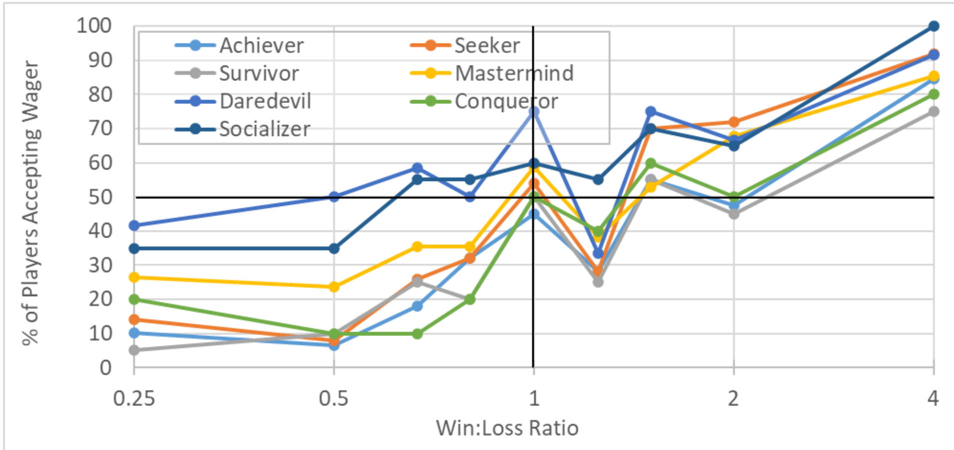

Figure 5.9: Acceptance of wagers by player type, in Experiment 2.

5.5 Player Attitudes Toward Gold in the Game

5.5.1 Attachment to the Gold

Seventy-one participants (63%) felt attached to their gold, with the most common reason give being the ability of buying a sword upgrade with it, which was also the most common reason in the previous experiment. As with the previous experiment, players got attached to their gold due to how hard they had to work to earn it, with some players viewing it as a source of power and measure of success. A small number of participants ended more attached to the gold after losing it in a wager ("After losing two rolls, I began to feel a little attached to my gold. I did want to see what buying a sword would feel like so I stopped doing the rolls until the end.", said P125), or when they were close to unlock the swords: "The closer I got to being able to upgrade the sword, the more attached I felt to my gold. I could feel myself becoming more protective and more anxious to try and collect more." (P138).

Surprisingly, the most common reason that 42 participants (37%) were not attached to their gold was also related to acquiring a sword, with players viewing gold only as a means to get a better sword: "I just viewed it as experience points that were meant to unlock the better swords." (P117). Many participants pointed out that the lack of purchasing options and the ease of acquiring more gold were also a factor for the detachment with their gold ("I wasn't using it. I feel less attached to currency if I can't trade it for goods and services. In this game it felt more like a high score than usable money.", said P109).

5.5.2 Purchasing Power

Eighty-one participants (72%) felt that the gold in the game had purchasing power, with the chance of exchanging it for one of the swords being the main reason (78 participants, 96%). Four participants mentioned that only allowing the player to buy a sword at the end of the game made the gold feel worthless until that point.

Most participants that did not felt that gold had purchasing power (32 participants, 28%) pointed out the impossibility of spending gold until the end of the game as a strong reason, followed by the long time it took to accumulate enough money to unlock the swords.

5.5.3 Saving Money for an Upgrade

The majority of participants (110 participants, 97%) were hoping to save enough money to buy the sword upgrades, with the main reason being that they assumed that acquiring the sword upgrades was the main goal of the game, which replicates the findings from Experiment 1. Other common reasons include:

- Curiosity about how the sword upgrade would change the game;
- To make fighting monsters easier and faster;
- To progress in the game faster.

One participant showed signs of being emotionally invested to the shopkeeper as the reason for saving gold: "I really wanted to stick it to that shopkeeper so I had to keep getting more gold." (P66).

The reasons that three participants (3%) were not hoping to save enough money to buy the sword upgrades were:

- The reward was not good enough;
- Assumed that the reward was too high and unobtainable;
- Just wanted to accumulate as much wealth as possible.

5.5.4 Avoiding the Trickster's Treasure Chest

One hundred and three participants (91%) avoided using the trickster treasure chest any point, with unfavorable odds (i.e., the lose amount was higher than the win amount) being the main reason, followed by previous losses. Some participants mentioned having to lose several times to feel discouraged of gambling, while others started avoiding wagering after the first loss: "After I lost money that first time I used the treasure, I never did it again. I didn't like that feeling, and I just didn't want to go near it.", said P58.

One participant started to figure out the manipulation we designed for the game, but still felt discouraged to wager when the odds were highly unfavorable and the gold amount was increasingly high: "I started to suspect that the Trickster's treasure would alternate between winning and losing on a regular cycle, but as the game progressed, the odds just go so much steeper at times that I decided not to risk it" (P21).

The main reasons reported that participants (10 participants in total, 9%) did not avoided using the trickster treasure chest any point were:

- Because it was fun to gamble;
- To be able to afford a new weapon faster ("I tried to keep using the chest to be able to afford a new weapon fast, but at the end I pretty much lost a bunch.", P31)

5.6 Player Satisfaction

As with the previous experiments, we analyzed the player responses to the question "How satisfied are you with your progress?" that was given after they interacted with the shopkeeper. Figure 5.10 shows the results: a loss led to a reduction of approximately 0.55 on the 5-point perceived-progress scale, whereas a win only led to an increase of 0.27. This replicates the takeaway from the previous study, suggesting that the effect of a loss was larger than the effect of a win, which is in line with previous work on loss aversion.

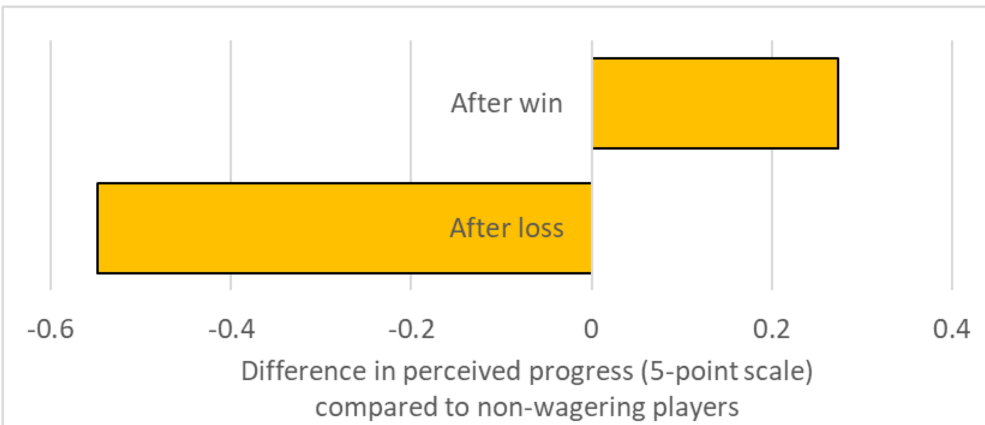

Figure 5.10: Relative change in perceived satisfaction after a win or a loss in Experiment 2, compared to players who did not wager.

5.7 Interpretation of Results

Evidence of loss aversion was shown in our analysis, with low wagers being accepted more often than high wagers, losses having a greater impact on players' satisfaction than gains, and women being, overall, more loss averse than men. Due to sample size, further investigation is needed to confirm effects of gambling propensity and player type in willingness to gamble. Further, we did not find evidence of effects of age to accept a wager.

The responses from our open-ended survey indicate that most participants perceived value in our game currency, wanted to save money for the sword upgrade, and felt that the game currency had purchasing power. The majority also avoided wagering at least once in the game, with the most common response being that previous losses made them more wary of wagering, followed by situations when the amount of gold they could lose by wagering was too higher in comparison to the amount they could win.

6 Results for Experiment 3

We decided to develop Experiment 3 to check if introducing fixed losses at 50% of the player's wealth would significantly change the results in comparison to Experiment 2, that did not had such restriction. The other big change was the separation of the low and high values of the wagers with ratio 1.25, as to have a clear understanding of how wager amount influences loss aversion for all ratios.

6.1 Participants

A total of 114 participants finished Experiment 3. After excluding participants (we used exclusion criteria similar to what was used on Section 4.1) who failed to provide answers to surveys (3 people), selected survey items faster than 1.5 sec/item (14 people), or displayed zero variance (3 SDs above mean variance) on two or more questionnaire subscales (1 participant), we ended with a total of 96 participants: 65 men, 29 women, two nonbinary; ages 19-65 (mean 34); playing 0-40 hours of videogames per week (mean 11.4). All participants were familiar with desktop and mobile apps, and most chose PC as their favorite platform (55%), followed by console (27%) and mobile (11.5%). Participants self-identified as Seeker (35%), Achiever (26%), Survivor (11%), Socializer (9%), Mastermind (7%), Conqueror (5%), or Daredevil (5%).

6.2 Did Loss Aversion Occur in the Game?

Of the 96 players, 93 wagered at least once during the 18 rounds of the game, and the average number of wagers accepted per player was 6.6 (37%). Figure 6.1 shows the percentage of players accepting the wager at each ratio. As can be seen from the chart, willingness to accept unfavorable wagers is low, but increases as the win:loss ratio improves, reaching 50% when the ratio reaches 1.0. However, at favorable wagers (where players stood to win more than they lost), people were no more likely to accept a wager until the ratio became strongly favorable at 4.0 (win amount is four times loss amount).

As with the previous experiments, we compared the rate at which players accepted and declined equivalent favorable and unfavorable wagers. Our pairs of equivalent win:loss ratios are 0.25 and 4.0, 0.5 and 2.0, 0.6667 and 1.5, and 0.8 and 1.25 (see Table 3.3). Comparing the pairs of equivalent wagers shows strong evidence of loss aversion (see Figure 6.2). We used paired Wilcoxon rank sum tests (two-tailed) to compare the accept/reject rates in each pair. Results are shown in Table 6.1: for each pair, the difference was highly significant, providing evidence that loss aversion was occurring at all wager ratios.

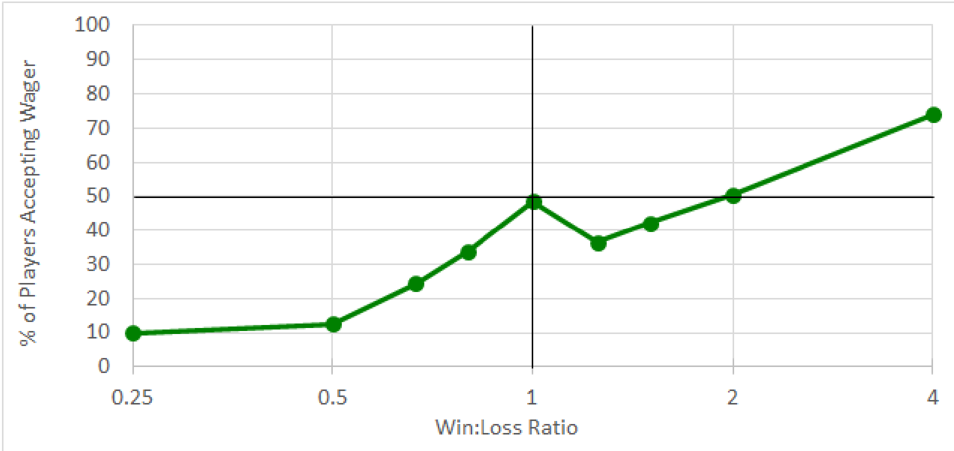

Figure 6.1: Overall acceptance of wagers by win:loss ratio, in Experiment 3.

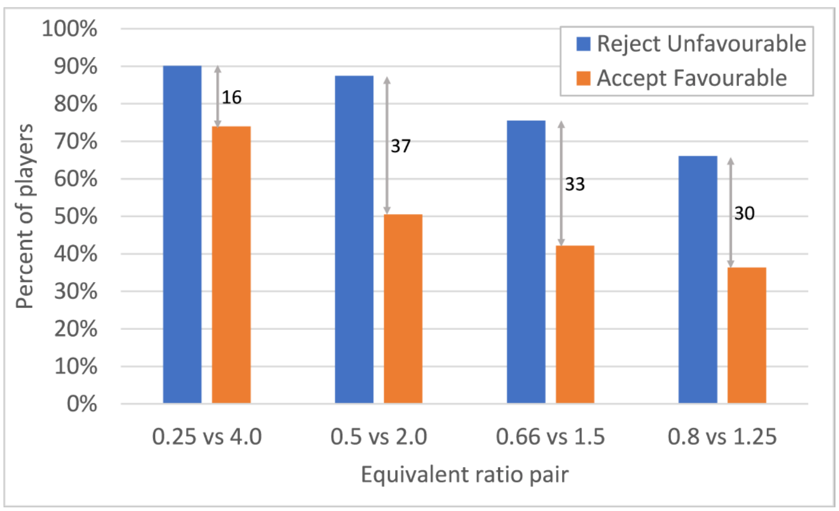

Figure 6.2: Rates of rejecting unfavorable ratios vs. accepting equivalent favorable ratios, in Experiment 3.

Table 6.1: Wilcoxon tests comparing reject rate for unfavorable ratios vs accept rate for favorable ratios, in Experiment 3.

Unfavorable ratio	Reject rate	Favorable ratio	Accept rate	V	p
0.25	90.1%	4.0	74.0%	1504	**<.0001**
0.5	87.5%	2.0	50.5%	5096	**<.0001**
0.66	75.5%	1.5	42.2%	6353	**<.0001**
0.8	66.1%	1.25	36.4%	7373	**<.0001**

6.3 Is Loss Aversion Affected by Wager Amount?

Low wagers were accepted more often (40% of the time overall) than High wagers (30% overall); see Figure 6.3.

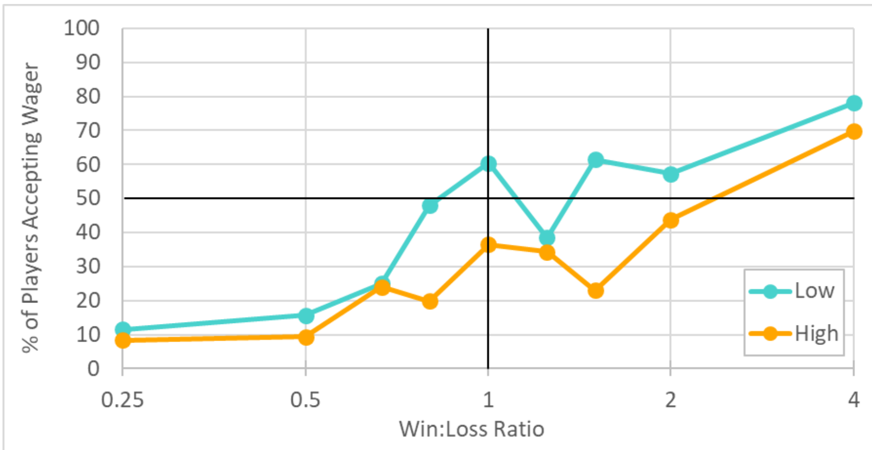

Figure 6.3: Acceptance of wagers by amount of the wager, in Experiment 3.

The results of our analysis of equivalent wagers for Low and High amounts is shown in Figure 6.4, and Wilcoxon rank sum tests (two-tailed) are reported in Table 6.2. Although loss aversion was evident for both Low and High amounts, the effect was much larger at High amounts.

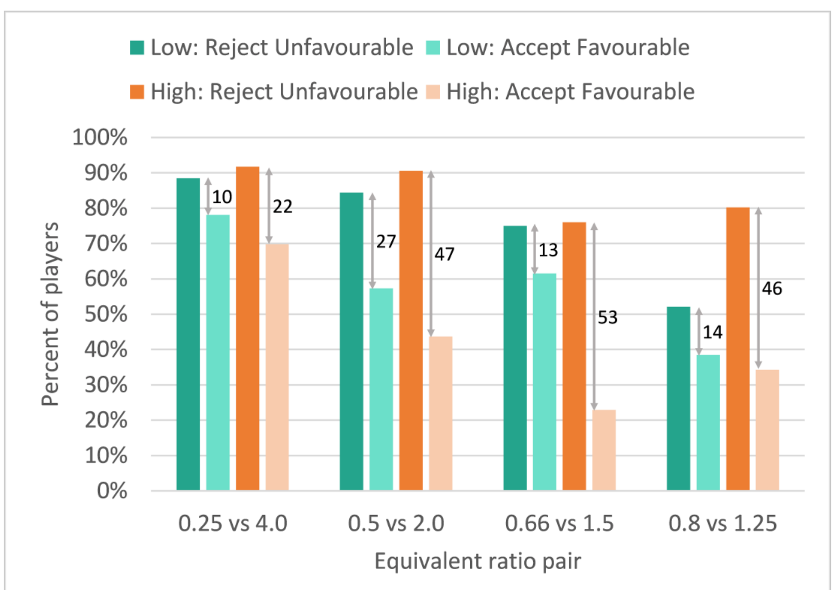

Figure 6.4: Rates of rejecting unfavorable ratios vs. accepting equivalent favorable ratios by wager amount, in Experiment 3.

Table 6.2: Wilcoxon tests comparing reject rate for unfavorable ratios vs accept rate for favorable ratios by amount of wager, in Experiment 3.

Unfavorable ratio	Reject rate	Favorable ratio	Accept rate	V	p
Low Amounts					
0.25	88.5%	4.0	78.1%	275	=.061
0.5	87.5%	2.0	50.5%	1033	=**.00032**
0.66	75.0%	1.5	61.5%	952	=.080
0.8	52.1%	1.25	38.5%	1360	=.11
High Amounts					
0.25	91.7%	4.0	70.0%	504	=**.00040**
0.5	90.6%	2.0	43.7%	1560	**<.0001**
0.66	76.0%	1.5	22.9%	2394	**<.0001**
0.8	80.2%	1.25	34.4%	2409	**<.0001**

6.4 Does Loss Aversion Change Across Player Groups?

As with the other experiments, we examined whether there were differences arising from several intrinsic factors in our players, including gender, age, player type, and gambling propensity. Since we cannot carry out multi-factor analyses to look for interactions, our analysis first considers overall differences in willingness to wager, and then considers possible differences in loss aversion through simple inspection.

6.4.1 Effect of Gender

In total, 94 of 96 players identified as either “woman” or “man” in our demographic questionnaire. Women accepted 41% of the 18 wagers, and men 35%; however, Wilcoxon tests comparing willingness to accept wagers showed no effect of gender at any ratio (all $p>0.05$). Figure 6.5 shows the proportion of men and women who accepted wagers at each win:loss ratio. Results from comparing equivalent wagers for the two genders are shown in Figure 6.6. Wilcoxon tests indicated that all differences between reject-unfavorable and accept-favorable were significant at $p<0.05$. As can be seen in Figure 6.6, the difference between rejecting unfavorable wagers and accepting favorable ones was similar for the first pair, and larger for men in the other three pairs. This stands in opposition to the prior experiments, as well as prior research suggesting that women are more loss averse than men: in our data, this pattern was not seen (if anything, the reverse was true).

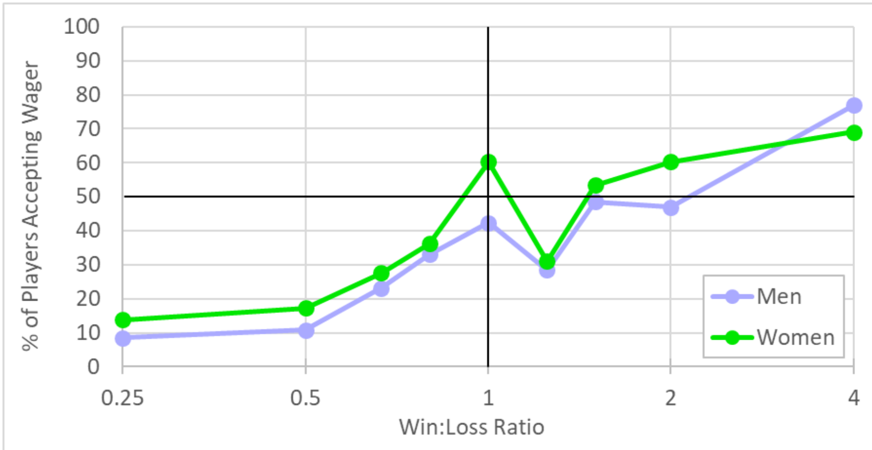

Figure 6.5: Acceptance of wagers by gender, in Experiment 3.

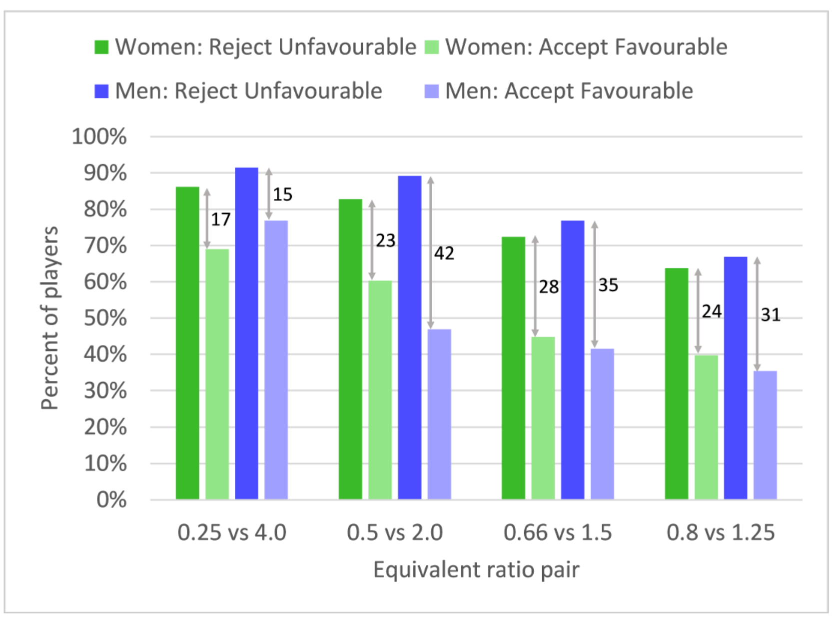

Figure 6.6: Rates of rejecting unfavorable ratios vs. accepting equivalent favorable ratios by gender, in Experiment 3.

6.4.2 Effect of Age

We grouped our participants into five categories: 19-25 (16 people, 39% of the 18 wagers accepted); 26-35 (44 people, 40%); 36-45 (26 people, 30%); and over 45 (10 people, 30%). Figure 6.7 shows these age groups' willingness to accept wagers at each win:loss ratio. Kruskal-Wallis tests (Bonferroni-corrected) at each ratio showed only one significant difference by age group (at ratio 2.0, p=0.0029, see Figure 6.7); for all other ratios, p>0.05. There was also no clear evidence of difference in loss aversion (although the difference at ratio 2.0 may suggest a trend for players over 35 to be more loss-aversive than players under 35).

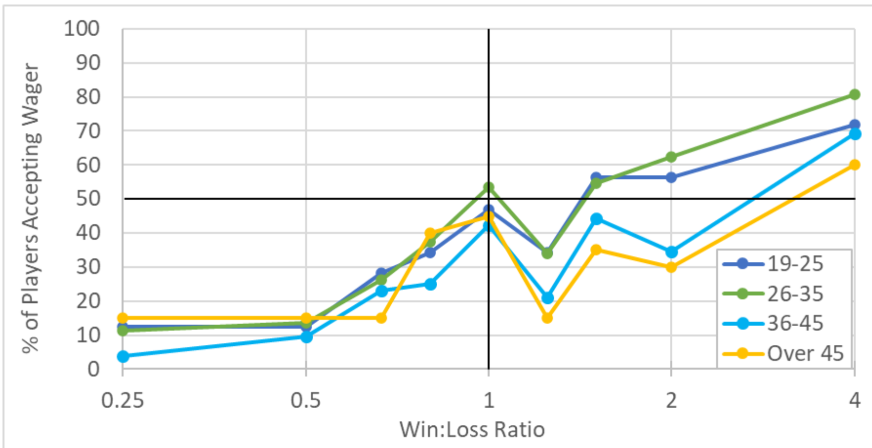

Figure 6.7: Acceptance of wagers by age group, in Experiment 3.

6.4.3 Effect of Gambling Propensity

Participants completed the PGSI questionnaire and were categorized as non-problematic (60 people, accepted 32.5% of the 18 wagers), low-risk (17 people, 43%) moderate-risk (13 people, 46%), and high-risk gamblers (6 people, 44%). Bonferroni corrected Kruskal-Wallis tests at each ratio showed no effect of PGSI risk group on willingness to wager (all p>0.05), although Figure 6.8 suggests that the high-risk group may behave differently than other groups both in terms of willingness to wager and loss aversion (however, as there were only 6 players in this group, a larger sample is needed for further investigation of this issue).

6.4.4 Effect of Player Type

Using the BrainHex model (see Section 3.5.1 for more details), participants self-identified as Seeker (34 people), Achiever (25), Survivor (11), Socialiser (9), Mastermind (7), Conqueror (5), and Daredevil (4). Kruskal-Wallis tests at each ratio showed no effect of player type on willingness to wager (all p>0.05). In addition, the data show no clear evidence of any differences in loss aversion by player type (see Figure 6.9).

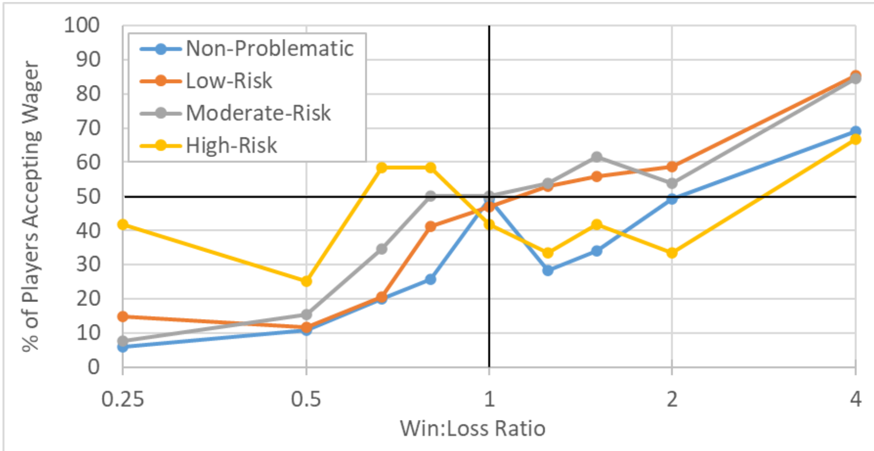

Figure 6.8: Acceptance of wagers by gambling risk group, in Experiment 3.

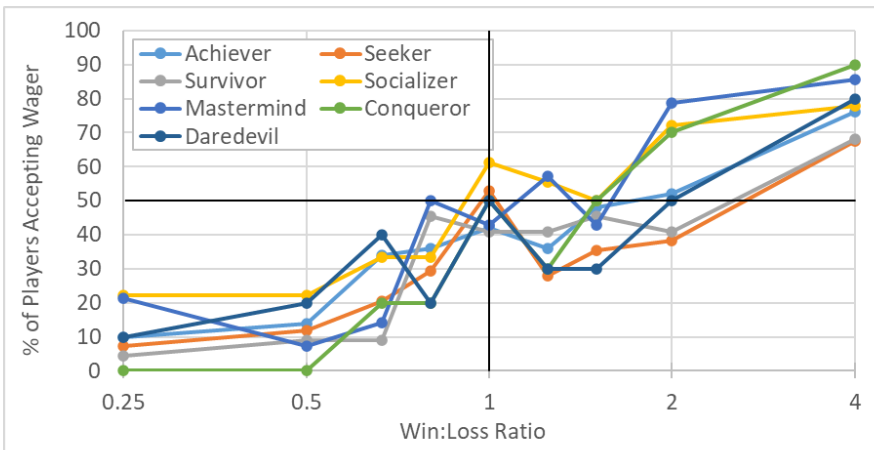

Figure 6.9: Acceptance of wagers by player type, in Experiment 3.

6.5 Player Attitudes Toward Gold in the Game

6.5.1 Attachment to the Gold

Sixty-five participants (68%) felt attached to their gold, and the most common reasons pointed out in this experiment where also mentioned in the previous ones, such as:

- Wanted to use it to buy the sword upgrade;
- Grew attached to it after losing money;
- Worked hard to earn it;
- Feared losing it to the trickster treasure chest.

Some participants viewed gold as a way to track progress in the game: "I still felt the gold was the way in which I could track my progress to the end of the game so I felt attached to it." (P23). One participant highlighted that, even after noticing that he was consistently getting lots of coins after losing for the trickster treasure chest in the previous round (i.e., noticed the game manipulation), he still stopped wagering at some points of the game for fear of losing gold.

As for the main reasons for participants not being attached to their gold (31 participants, 32%), they were:

- It was just a means to get the better sword;
- The amount of gold earned increased drastically per level, so even after losing it was always possible to earn it back;
- It was not possible to spend it on anything until the end of the game;
- It was just play money.

One of the participants that viewed gold as play money pointed out that, despite not being attached to the gold, that would not be the case if the gold was lost by means of combat (i.e., receiving damage from an enemy).

6.5.2 Purchasing Power

Sixty-three participants (66%) felt that the gold in the game had purchasing power, with being able to buy a new sword the major reason for most players (48 participants, 76%). Several participants mentioned that, despite feeling that gold had purchasing power, it was diminished by the lack of purchasing options, the time it took to be able to buy something, and the high cost of the swords available.

Thirty-three participants (34%) did not felt that the gold had purchasing power. The reasons were the same as with the previous experiments: gold was not useful until the end of the game, it took too much time to be able to purchase a upgrade, the cost was hidden for the most part, and there were limited purchase options available. One participant expressed that they was not sure if gold could really purchase something: "Nothing made me think I could buy real things with the money in the game. The only thing I could purchase was a sword of unknown value.", said P104. Another participant mentioned that the cost of the swords being hidden made the gold lose a reference point, which made hard to find value collecting gold: "There was no reference point to the value of the money. It wasn't until the very last shop that there was any concept of how much the only things I could buy were worth, and due to how quickly the values were escalating it just didn't feel like it had much value to begin with.", said P68.

6.5.3 Saving Money for an Upgrade

Ninety-five participants (99%) were hoping to save enough money to buy the sword upgrades. The main reasons given to the previous experiments were the same for Experiment 3, such as defeating enemies faster, and assumed that was the main goal of the game. The reason that only one participant was not hopping to save enough money for the sword upgrades was that they knew that they would eventually have enough gold to buy it.

6.5.4 Avoiding the Trickster's Treasure Chest

Ninety-two participants (96%) avoided using the trickster treasure chest any point. As with the previous experiments, unfavorable odds and previous losses where the most common reasons mentioned. One participant highlighted that the name "trickster's treasure" made them more wary of wagering: "I tried Trickster's treasure the first 3-4 times I was able to, but I lost money every time. It could just be bad luck, but that combined with the name "Trickster's treasure" made me think I actually may never win." (P61).

The main reasons reported that four participants (4%) did not avoided using the trickster treasure chest any point were:

- Wanted more gold;
- Did not had self-control to stop using it;
- Needed the sword (no reason given);
- Was playing the game very well.

6.6 Player Satisfaction

As with the previous experiments, we looked at player responses to the question "How satisfied are you with your progress?". A loss led to a reduction of 0.53 on the 5-point perceived-progress scale, whereas a win only led to an increase of 0.28 (see Figure 6.10). This result reinforce the results from the previous experiments, suggesting that the effects of a loss were larger than a win.

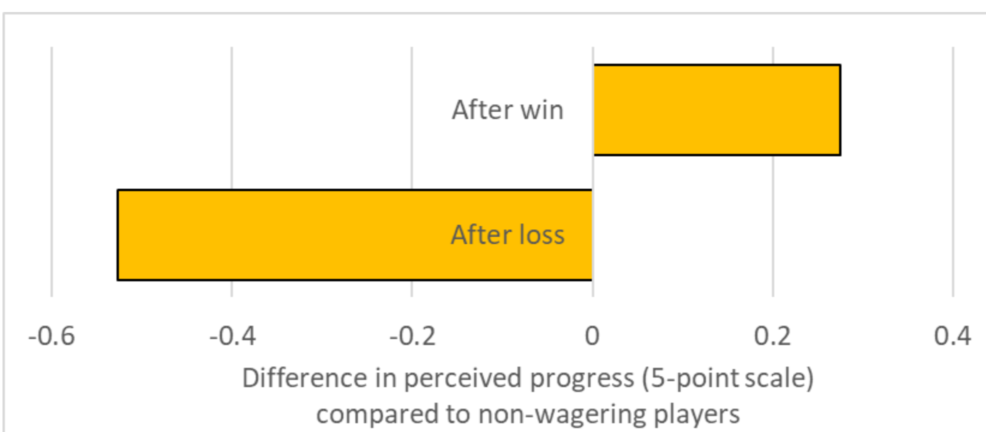

Figure 6.10: Relative change in perceived satisfaction after a win or a loss in Experiment 3, compared to players who did not wager.

6.7 Interpretation of Results

Participants from Experiment 3 showed strong evidence of loss aversion, being the most loss averse when comparing all experiments. Low wagers were accepted more often than high wagers, and losses had a greater impact on players' satisfaction than gains. We did not find significant evidence of effects of gender to accept a wager, as well as age, gambling propensity, and player type.

As with the previous experiments, the responses from our open-ended survey indicate that we had success with introducing sword upgrades as a way to give utility to our game currency, with the majority of participants wanting to save money for the sword upgrade and feeling that the game currency had purchasing power. The majority of participants also avoided wagering at least once in the game, with previous losses and unfavorable wagers (i.e., loss amounts higher than win amounts when wagering) being mentioned as the main reason.

7 Discussion

7.1 Comparison Between the Three Experiments

We present Table 7.1 and Table 7.2 as a way to highlight the main differences in results between the three experiments:

Table 7.1: Comparison of results from Experiment 1, 2, and 3, showing if conclusive evidence of loss aversion was found for each of the measures analyzed.

Overall	Amount	Gender	Age	Gambling Propensity	Player Type
Experiment 1					
Yes	Yes	Yes	No	No	No
Experiment 2					
Yes	Yes	Yes	No	No	No
Experiment 3					
Yes	Yes	No	No	No	No

Table 7.2: Comparison of results from Experiment 1, 2, and 3, showing the differences in perceived satisfaction in each of the experiments.

Player Satisfaction
Experiment 1
A loss lead to players five times less satisfied than a win.
Experiment 2
A loss lead to players two times less satisfied than a win
Experiment 3
A loss lead to players two times less satisfied than a win

7.2 Main Results

This chapter discusses the main results generated from all three studies. Our experiments, with 300 participants in total, provide five main results:

- All studies clearly demonstrated the presence of loss aversion: players were significantly biased towards avoiding the losses from unfavorable wagers;

- All studies clearly demonstrated the presence of loss aversion: players were significantly biased towards avoiding the losses from unfavorable wagers;

- The overall likelihood of accepting a wager only notably exceeded 50% when the wager's win amount was more than double the loss, for all experiments;

- In all studies, the values involved in the wager had a significant effect on the likelihood of acceptance: overall, players accepted a smaller proportion of wagers involving larger amounts than those involving smaller amounts, despite the wagers having equivalent win:loss ratios;

- There was a significant difference in willingness to wager based on gender in two (Experiment 1 and 2) of the three experiments, and, for all experiments, no significant conclusive difference with the other demographic variables analyzed (age, gambling propensity, and player type) was found;

- In all studies, losses had more of an effect on subjective satisfaction than wins – satisfaction decreased more when players lost a wager than it increased after a win.

In the following sections, we consider explanations for these findings, discuss the implications of our results for game designers, and outline potential limitations and avenues for further research on loss aversion in game contexts.

7.3 Explanation for Main Results

7.3.1 Presence of Loss Aversion in Video Game Players

Our studies clearly showed the presence of loss aversion: in all experiments, players were much more likely to refuse unfavorable wagers than they were to accept equivalent favorable ones; wagers with favorable win:loss ratios were frequently declined; and wagers were only notably accepted when the win was more than double the loss. To explain these results, we return to the questions raised at the start of the paper regarding players' decisions in games.

Three factors suggested that loss aversion may be reduced in games: the "magic circle" that allows players to engage in activities that they would not undertake in their ordinary lives; the virtual nature of game assets (i.e., wagers in the game are not "real money"); and the idea that gambling may be primarily hedonic rather than utilitarian. In contrast, the idea that game assets often have a clear utility for reaching a goal within the game argues that loss aversion may still occur, although it will be re-calibrated to the reward structure of the game.

Our results align with the last of these explanations – it appears that players saw their gold as having a clear utility (i.e., for purchasing a more powerful sword). Further evidence for this interpretation can be seen in the players' responses to questions about whether they felt that their gold had purchasing power (76%, 72%, and 66% of participants said yes in Experiment 1, 2, and 3, respectively) and whether they were trying to get enough gold to purchase the better sword (96%, 97%, and 98% said yes, respectively).

However, the results also suggest that loss aversion in the game may differ from that in the real world. First, people who stated that they do not take financial risks in the physical world — 75%, 77%, and 81% of participants in Experiment 1, 2, and 3, respectively — still accepted, on average, 4.3 of the 10 wagers in Experiment 1, 7.5 of the 18 wagers in Experiment 2, and 6.5 of the 18 wagers in Experiment 3. Further, even people who reported that they do not take financial risks in games — 38%, 32% , and 34% of participants in Experiment 1, 2, and 3, respectively — still accepted, on average, 3.8 of the 10 wagers in Experiment 1, 6 of the 18 wagers in Experiment 2, and 4.5 of the 18 wagers in Experiment 3. Furthermore, our results for wagers with an equal win and loss (ratio 1.0) showed acceptance at 50% in all experiments. In contrast, results from behavioral economics suggest that these wagers would be reduced in the physical world [76].

Given these results, a remaining question is why we did not see stronger effects of the magic circle, the virtuality of game assets, and the hedonic nature of gambling. Our interpretation is that although these factors may have played a role in altering players' willingness to gamble overall, the utility of a player's gold in reaching a game objective outweighed any influences towards risk-taking, allowing people's natural loss aversion to dominate. Thus, despite the game's lack of reality, players maintained a sense of what was valuable in the game. This is not surprising – designers have long known that players are keenly aware of minor differences in the power of different characters or weapons – but players' ability to understand utility relationships in games means that designers could beneficially account for biases like loss aversion when thinking about reward structures and decision points (discussed further below).

7.3.2 Loss Aversion and Value of the Wagers

We found that gambling behavior was significantly affected by the amount of the wager in all experiments. Previous work has shown conflicting results in this regard (e.g., [58]), but many of these studies differ from our game in that large-value prospects offered to participants are only theoretical (i.e., they ask participants whether they would take certain wagers, but do not show an outcome, and do not either pay out to or collect from the participant). Players in our game, in contrast, really saw the outcomes of the wagers, and were clearly affected by these outcomes (as shown by the satisfaction measures), which may have accentuated their loss aversion with higher amounts. Further study is needed, however, to determine whether the effect of amount is relative to the cost of the goal (e.g., the sword in our game), to the difficulty of acquiring more of an asset (e.g., if gold was rare in our game, it might change players' sensitivity to wager amount), or how the wagers were framed.

7.3.3 Loss Aversion and Gender

There are many studies that investigates demographic factors that can influence loss aversion, one of them being gender. A sizable number of researchers affirm that, in general, women are more loss averse than men (e.g., [29, 44, 110]), and the results of Experiment 1 and 2 corroborates with this conclusion. However, there are many studies that could not find conclusive difference in gender [3, 40, 64], which mimics the results of Experiment 3. Durant et al. [40] provides a possible explanation for this, suggesting that personality traits – such as extraversion and neuroticism – have a bigger role influencing loss averse behavior than gender. Our results may also be attributable to slight variations in the definition of "loss aversion", which have been found to radically influence results concerning gender susceptibility to loss aversion [27]. As the literature regarding gender influence on loss aversion is still inconclusive, further study – especially that which considers personality variables alongside gender, as well as work towards the consolidation of a loss aversion definition in light of gender effect – is recommended.

7.3.4 Loss Aversion and Player Subjective Satisfaction

Participants' level of subjective satisfaction with their progresses was significantly affected by the outcome of their wagers in all experiments, with losses having a greater impact than wins. This difference was especially larger in Experiment 1, with participants being five times more dissatisfied losing in comparison to winning, and approximately twice as dissatisfied when losing in the other experiments. These results highlight the challenges of designing and balancing punishment in gameplay systems, that can attract and sustain players and promote players' growth instead of stress and anxiety, particularly with the ones characterized by permanent losses of progress, such as roguelike games [1].

7.4 Implications for Game Design

Games often seek to create conflicting decision points for players using mechanical and moral dilemmas. For example, in a first-person shooter such as *Counter-Strike:GO*, a player may need to choose between the high-risk, high-reward sniper rifle, and the more reliable – but less powerful – assault rifle. In a narrative-based roleplaying game à la *The Witcher* series, a player may need to decide whether to spare or execute a villainous NPC. Decisions, risks, rewards, and losses are inherent to gameplay, and yet are rarely considered through the lens of cognitive biases like loss aversion.

Game designers often need to balance player autonomy and sense of control, and this, coupled with loss aversion theory, can be used to dissuade players from taking certain actions. For example, by limiting the content that players can have access (e.g., new levels, cosmetic features) based on how players interact with the game world (e.g., players that only repeat the same strategy over the game are rewarded with a lower stage ranking, limiting the number of bonuses, such as skins, that they can unlock).

But beyond the creating of interesting decision points, game designers may also be able to take advantage of loss aversion by giving players a resource that suffers attrition or decay. To avoid the negative sense of loss, players could be extrinsically motivated to engage in behaviors to mitigate that loss. This design paradigm is already in effect in games such as *Overwatch*, where players' skill ranking decreases if they do not play a ranked game for several days. While forcing players to behave a certain way to avoid losses may seem to work against player interests, this technique could be employed in contexts that help to promote positive player experiences (e.g., by preventing toxicity in multiplayer games). As an example, multiplayer games could assign players a "community standing" resource, seeded with a relatively high value, with code of conduct violations penalized by decrementing the value.

Speculatively, loss aversion may also have implications for why some people stop playing a game, either within a play session, or permanently. If players reach a point where progression in the game puts their resources at risk, or forces a loss onto the player, it may be more rational to stop playing before the loss is realized, rather than realizing the loss and experiencing the hedonic consequences. For example, if a player is on a win streak, continuing the play session may threaten to interrupt the win streak – making it preferable to stop playing while the player is 'ahead'.

Besides the general suggestions on how to apply loss aversion theory in games mentioned previously, the main takeaway from this research is that loss aversion not only exists in games but has a strong impact in player's decision, and game designers need to take this psychology bias in consideration when developing their games, even in the early stages of concept.

7.5 Limitations and Opportunities for Further Research

This research focused on the investigation of a purpose-built *Zelda*-like adventure game. As player experiences differ notably between genres and gameplay, further study is needed to generalize findings to other genres, play formats, and perspectives. For example, it may be that games that offer more immersive experiences – such as narrative-based roleplaying games – induce greater loss aversion due to the player's involvement in the game world, narrative arc, or connection to the player-character. Likewise, the occurrence and magnitude of loss aversion may differ in multiplayer games due to players' concerns about how their actions are perceived by others, such as fearing "losing face" or appearing irrational.

Previous research on prospect theory and the framing effect suggests that people avoid risks when they are presented in a positive frame, but actively seek these risks to try to avoid a loss or recover from a previous loss. In other words, having questions with identical outcomes framed differently from each other could result in different responses from the players. In our studies we did not change how the wager questions were framed, since for these first studies we mainly wanted to see if the hedonic nature of games would make players behave differently than they behave in other contexts when faced with similar choices, but this idea is worth investigating for a future study.

Although there are variables other than wager amount, such as fatigue and familiarity, that could affect a player's decision to accept the wager, we do not capture these explicitly from participants in all experiments, and thus cannot model their potential influence. Our game's design meant that wager amounts increased, just as fatigue and familiarity do, so future work may want to account for these potentially latent factors.

While efforts were taken to ensure that our bespoke game had a high degree of ecological validity in all experiments, the game did not include a save feature. In games where players have the option to save before risks, "save scumming" (cheating behavior where players load the game if they receive a non-favorable outcome) could undermine effects of loss aversion. Investigating the impact of cheating behaviors on loss aversion was outside the scope of this investigation but may be an area for future work.

This research explored the presence and influence of loss aversion in games through wagering currency. While this allowed for more direct comparison with loss aversion literature (in which wagering is often the experimental manipulation), there is a variety of both decision types and "assets/valuables" that could be studied in gameplay. For example, many popular multiplayer games – such as *Fortnite*, *League of Legends*, and *Apex Legends* – prominently feature a persistent kill-death ratio attached to a player's public profile. Loss aversion may influence a player's in-game behavior with these assets as well, prompting them to avoid situations that might adversely affect their kill-death ratio.

Our experimental method involved a sequence of wagers, ranging from 10 to 18 depending on the experiment, with participants immediately seeing the outcome of any wager they accepted. It is therefore possible that the outcome of their last accepted wager may have influenced their subsequent decision, and the results from the qualitative data collected in all experiments show evidence of this issue. While our method is consistent with many other studies, cautions have been raised regarding the cross-condition contamination that can occur in decision series [125]. Future work could examine this as a potential influence on player decision, including the possibility and influence of recency and serial position effects.

Furthermore, it is also possible that players considered the effect of wagering on their overall wealth – and that the current totality of their assets influenced their likelihood to accept or decline a wager. While it is ideal to be mindful of this, literature generally suggests that most participants do very little asset integration (i.e., the degree to which people consider their current ownings) when evaluating a prospect or a wager [5, 19, 89]. As such, we make the assumption that the win:loss ratio has more effect on a participant's decision to wager than their current accumulated wealth.

While our results suggest that the majority of players valued their gold, it is possible that our MTurk participants prioritized a quick completion of the experiments, and that they were therefore less likely to experience the game in a representative way. Future research may benefit from the exploration of loss aversion in a commercial game, and – with it – the utilization of a real playerbase. It is possible that loss aversion is moderated (potentially increased) by an intrinsic motivation to play.

Future work may also benefit from considering various aspects of play that strengthen player involvement, connection, or immersion. For example, a player who feels more connected to or represented by their player-character may also engage in more loss aversive behaviors. Allowing a player to customize a player-character to best represent themselves may result in an increase of utility and value evaluation of game currency.

Finally, the fact that players do appreciate the utility of assets in games allows us a new opportunity to test hypotheses that have been difficult to explore in physical-world studies of loss aversion. For example, asset integration studies have only been able to ask participants what they *would* do, rather than have them actually risk valuable assets. In games, we can now simulate these dilemmas and explore them in an accessible, modifiable, and economical context. This allows researchers to shift the context of asset integration and loss aversion studies from hypothetical and smaller sums to a representative exploration of loss aversion in high-value scenarios.

8 Conclusion

This work represents an initial step toward understanding whether and to what extent loss aversion occurs in digital games. Our studies involved the design of a *Zelda*-style game that made use of wagering to test loss aversion across a set of decision points, with three experiments made in total. The wagers' win:loss ratios were chosen so that we could examine whether people would be willing to take bets with different levels of loss or gain, with 50% odds throughout.

Our results were consistent with loss aversion. In all experiments, participants were significantly less likely to take a wager — especially with wagers involving high monetary values — when the amount they could lose was lower or not significantly higher than the amount they could win, despite the odds of the wagers remaining consistent. Demographic factors of age, player type and gambling risk did not significantly influence loss aversiveness in all experiments, and despite a significant difference being found with women being more loss averse than men in two of the experiments, it is unclear if gender is a reliable factor to predict loss aversion. Finally, we contrasted players' subjective satisfaction with the game, taken from our decision points after each wager. We found that players' satisfaction with their progress was substantially lower from losing a wager than it was increased from winning a wager, for all experiments. Taken together, these findings offer support for the existence of loss aversion in games.

In response to arguments around loss aversion being improbable as players would view their money as "play money", we also found evidence that most players valued their gold in game. We found that most players reported feeling attached to their gold and feeling that their gold had purchasing power.

Loss aversion has many implications for designing and understanding games – especially games that contain permadeath, that reward survival time, or that invoke a loss upon player failure states. Through greater consideration of loss aversion, game designers can realize increased authorial control, and both designers and researchers may be able to discreetly influence a range of player behaviors. Our increased understanding of loss aversion offers a wealth of opportunities, both in terms of exploration for future work in this area, and in the development of better player experiences.

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Appendix A

Consent Form

Before proceeding, please read the following. You must give your consent to continue.

You are invited to participate in a research study entitled: **Examining player experience in game scenarios.**

Researcher(s): Natanael Tome
Department of Computer Science, University of Saskatchewan, natanael.bandeira@usask.ca

Co-supervisor: Madison Klarkowski (Faculty)
Department of Computer Science, University of Saskatchewan, madison@cs.usask.ca

Cody Phillips (Faculty)
Department of Computer Science, University of Saskatchewan, cody@cs.usask.ca

Regan Mandryk (Faculty)
Department of Computer Science, University of Saskatchewan, regan@cs.usask.ca

Andy Cockburn (Faculty)
Department of Computer Science, University of Canterbury, andrew.cockburn@canterbury.ac.nz

Supervisor: Carl Gutwin (Faculty)
Department of Computer Science, University of Saskatchewan, (306) 966-8646, gutwin@cs.usask.ca

Purpose(s) and Objective(s) of the Research:

- This study will examine player experience in different scenarios in a top-down-style action-adventure game.

Procedures:

- After completing a demographics questionnaire, participants will play a web video game. Interaction data will be logged by the system, and the participant will be asked questions about prior experience with video games and preferences.
- This study will take around 1h to complete.

Funded by:

- Natural Sciences and Engineering Research Council of Canada - Discovery Grant

Figure A.1: Consent form part 1

Potential Risks:

- There are no known or anticipated risks to you by participating in this research except for possible minor arm/hand/finger tiredness. Participants are free to take periodic breaks to rest their hands between levels.

Potential Benefits:

- Participants will be contributing to a better understanding of game design and player experience in different scenarios. This knowledge can help the development of better digital games.

Confidentiality:

- All data will be gathered electronically. No personally-identifiable information will be stored with the data (i.e., all study data will be anonymized using a participant ID number)
- Data will be securely stored on a password protected computer. All data will be stored for 5 years by the primary investigator.
- When the data is no longer required, it will be destroyed by electronic file deletion.

Right to Withdraw:

- Your participation is voluntary. You may withdraw from the research project for any reason, at any time without explanation.
- Should you wish to withdraw, you may do so at any point, and we will not use your data; we will destroy all records of your data.
- Your right to withdraw data from the study will apply until the data have been aggregated (one week after study completion). After this date, it is possible that some form of research dissemination will have already occurred and it may not be possible to withdraw your data

Follow up:

- To obtain results from the study, please email natanael.bandeira@usask.ca two months after the study has been completed.

Questions or Concerns:

- Contact the researcher(s) using the information at the top of page 1;
- This research project has been approved on ethical grounds by the University of Saskatchewan Research Ethics Board. Any questions regarding your rights as a participant may be addressed to that committee through the Research Ethics Office ethics.office@usask.ca (306) 966-2975. Out of town participants may call toll free (888) 966-2975.

Do you give your consent?

○ I give my consent

○ I do not give my consent

Figure A.2: Consent form part 2

Appendix B

Questionnaires

Please answer the following questions.

Age:

Gender

- Man
- Woman
- Non-binary
- Prefer not to disclose

Major or profession:

Enter your major or profession

Amount of computer use per week on average (hours):

What applications do you typically use? (desktop and mobile) (e.g., Office, Facebook Mobile)

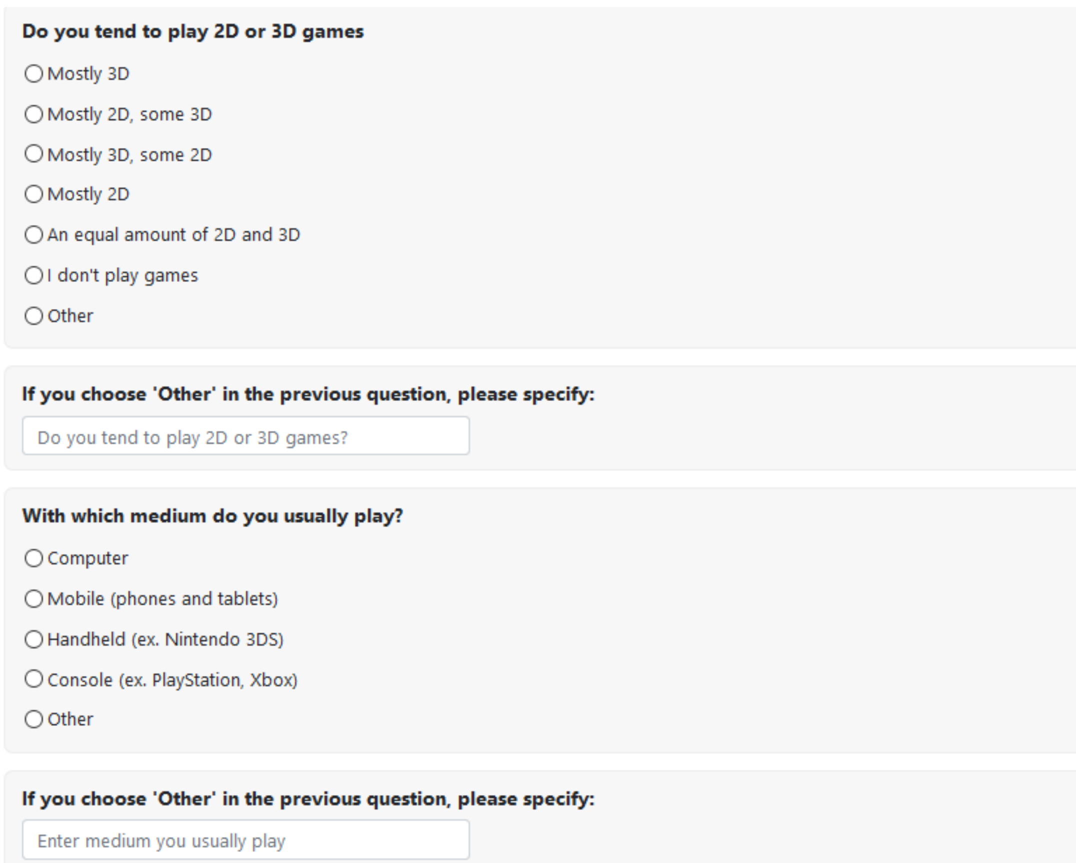
Enter applications you use

How many years have you been playing video games?

Amount of digital game play per week (hours)

If you have played more video games in the past, how many hours were you playing per week on average?

Figure B.1: Demographics Questionnaire part 1


Do you tend to play 2D or 3D games

- Mostly 3D
- Mostly 2D, some 3D
- Mostly 3D, some 2D
- Mostly 2D
- An equal amount of 2D and 3D
- I don't play games
- Other

If you choose 'Other' in the previous question, please specify:

Do you tend to play 2D or 3D games?

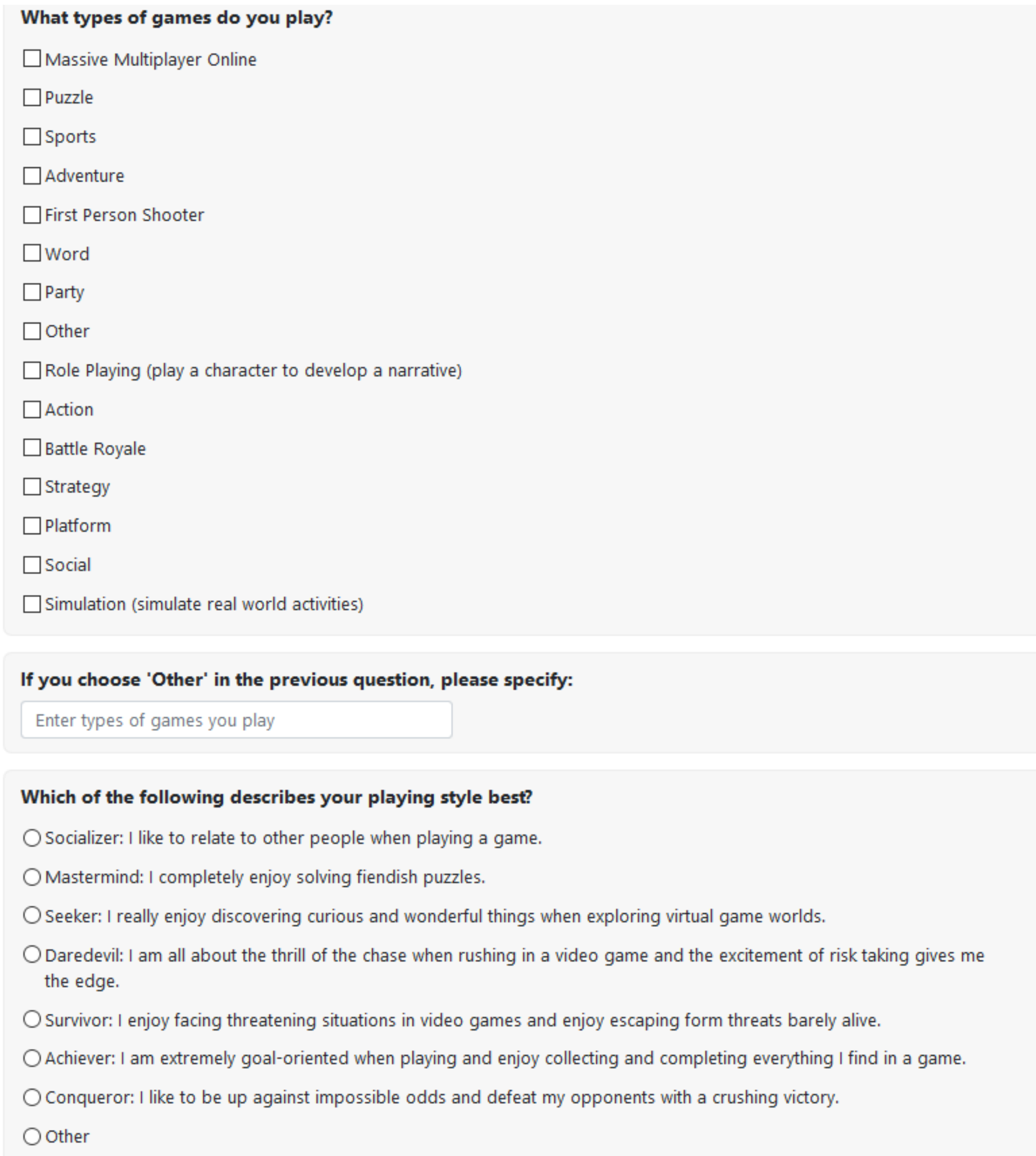
With which medium do you usually play?

- Computer
- Mobile (phones and tablets)
- Handheld (ex. Nintendo 3DS)
- Console (ex. PlayStation, Xbox)
- Other

If you choose 'Other' in the previous question, please specify:

Enter medium you usually play

Figure B.2: Demographics Questionnaire part 2



What types of games do you play?

- [ ] Massive Multiplayer Online
- [ ] Puzzle
- [ ] Sports
- [ ] Adventure
- [ ] First Person Shooter
- [ ] Word
- [ ] Party
- [ ] Other
- [ ] Role Playing (play a character to develop a narrative)
- [ ] Action
- [ ] Battle Royale
- [ ] Strategy
- [ ] Platform
- [ ] Social
- [ ] Simulation (simulate real world activities)

If you choose 'Other' in the previous question, please specify:

Enter types of games you play

Which of the following describes your playing style best?

- ○ Socializer: I like to relate to other people when playing a game.
- ○ Mastermind: I completely enjoy solving fiendish puzzles.
- ○ Seeker: I really enjoy discovering curious and wonderful things when exploring virtual game worlds.
- ○ Daredevil: I am all about the thrill of the chase when rushing in a video game and the excitement of risk taking gives me the edge.
- ○ Survivor: I enjoy facing threatening situations in video games and enjoy escaping form threats barely alive.
- ○ Achiever: I am extremely goal-oriented when playing and enjoy collecting and completing everything I find in a game.
- ○ Conqueror: I like to be up against impossible odds and defeat my opponents with a crushing victory.
- ○ Other

Figure B.3: Demographics Questionnaire part 3

For the following questions, please try to provide as much detail as possible to your answer.

Did you avoid using the Trickster's treasure at any point?

○ Yes

○ No

Please explain your previous response.

Did you feel satisfied with your choice to risk or not risk your money?

○ Yes

○ No

Please explain your previous response.

Did you feel that the money in the game had purchasing power?

○ Yes

○ No

Please explain your previous response.

Figure B.4: Qualitative Questionnaire part 1

Did you feel attached to your gold?

○ Yes

○ No

Please explain your previous response.

Were you hoping to save enough money to buy the sword upgrades?

○ Yes

○ No

Please explain your previous response.

Do you often take financial risks in real life?

○ Yes

○ No

Please explain your previous response.

Do you often take financial risks in video games?

○ Yes

○ No

Figure B.5: Qualitative Questionnaire part 2

Please explain your previous response.

If your risk tolerance in video games is different to your risk tolerance in real life, why do you think they are different?

Do you have any other comments about the game?

Figure B.6: Qualitative Questionnaire part 3

In regards to gambling, when you think of the past 12 months, how often...

	Never	Sometimes	Most of the time	Almost Always	Don't know
Have you borrowed money or sold anything to get money to gamble?	○	○	○	○	○
Have you needed to gamble with larger amounts of money to get the same feeling of excitement?	○	○	○	○	○
Have you felt people criticized your betting or told you that you had a gambling problem,regardless of whether or not you thought it was true?	○	○	○	○	○
Have you bet more than you could really afford to lose?	○	○	○	○	○
Has your gambling caused any financial problems for you or your household?	○	○	○	○	○
Have you felt guilty about the way you gamble, or what happens when you gamble?	○	○	○	○	○
Have you gone back another day to try to win back the money you lost?	○	○	○	○	○
Has your gambling caused you any health problems, including a feeling of stress or anxiety?	○	○	○	○	○
Have you felt that you might have a problem with gambling?	○	○	○	○	○

Figure B.7: PGSI Questionnaire